THE FOUNDRY

Vol. 44, No. 6
Whole No. 286

Cleveland, Ohio
June, 1916

Casting Hubs Onto Wheels in a Specialty Shop

How a Small, Well-Equipped Foundry Can Be Operated Economically as a Department of a Large Manufacturing Plant

TUCKED away in one corner of the extensive plant of the Sterling Wheelbarrow Co., Milwaukee, and which by no means constitutes the least important of the numerous departments of these works, is a gray iron foundry which specializes solely in the casting of hubs for wrought iron wheels for wheelbarrows. The Sterling Wheelbarrow Co., which is well-known to the foundry trade as a manufacturer of steel flasks, has equally as large a capacity for the production of all kinds of steel wheelbarrows and every part of these industrial conveyances is shaped and built in this plant. Before the foundry was installed, the wheels were purchased, but some years ago it was decided that dependence upon outside makers for even so small a part as the wheel was unsatisfactory and thus the hub casting plant came into being. Nor is the output limited to hubs for wheelbarrow wheels alone, since large shop trucks also are made and the hubs for these large wheels also are cast in this plant.

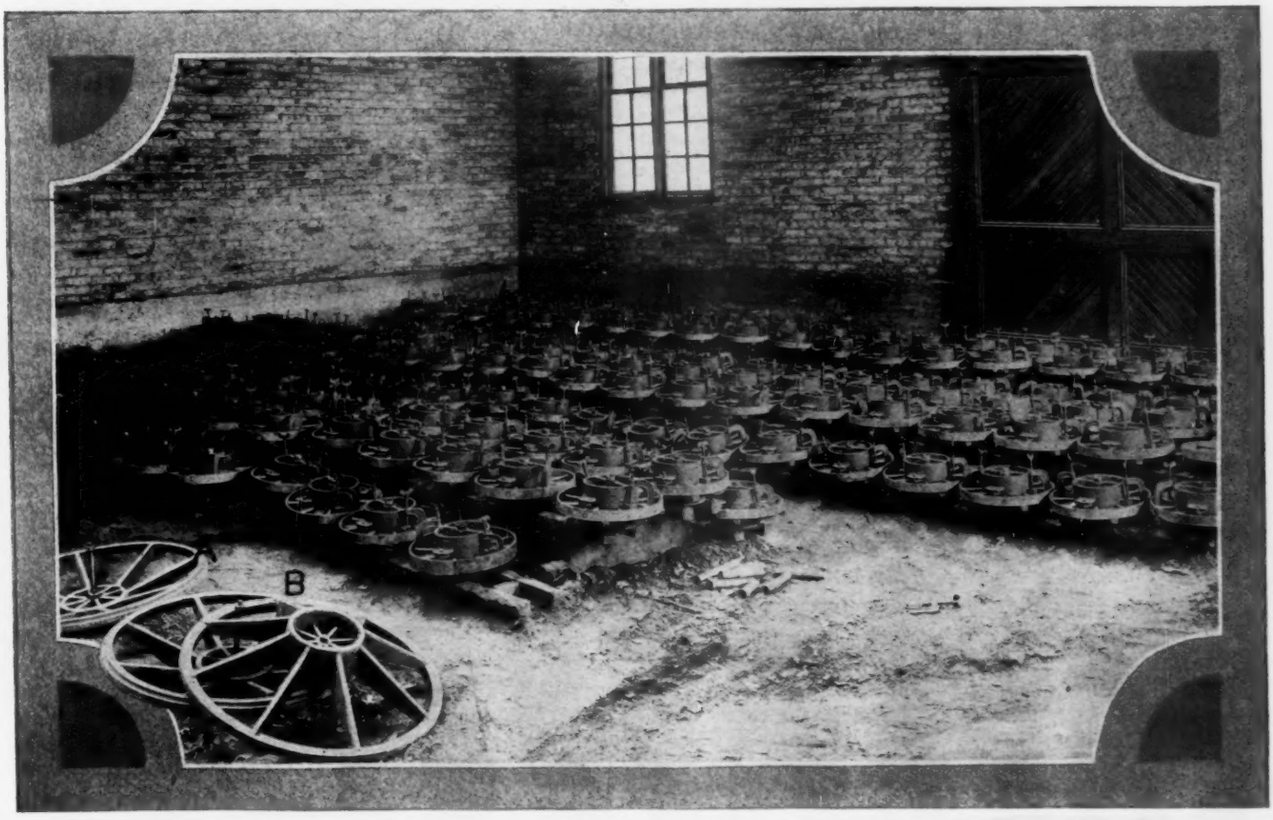


FIG. 1—INTERIOR VIEW OF A SPECIALTY FOUNDRY IN WHICH HUBS ARE CAST ONTO THE SPOKES OF WHEELBARROW WHEELS

Although small in size and output, the foundry is unusually complete in its appointments, the latter term better describing its mold-making, melting, handling and pouring devices than the word equipment. The shop, however, is highly specialized and is an excellent example of what can be done along this line when the castings are limited in form and variety. The organization, however, is complete in every detail despite the doubling-up of molder and helper, and suprintendent and working foreman.

In Fig. 1 is illustrated a day's output of hub molds for 15½-inch wheelbarrow wheels which have a ¾-inch bore. These molds cover practically the entire available molding floor area, three men putting-up 240 before the iron comes down and occasionally also twenty 36-inch wheel with staggered spokes for shop trucks which have a 1¼-inch bore. The cupola is of the baby or experimental type and has a capacity of 1,000 pounds per heat with a coke consumption of 280 pounds, the fuel ratio being 1 to 3.57. This, of course, does not compare favorably with that of larger melting mediums, but the small output must be taken into consideration when passing upon this practice.

As previously noted, the operations are highly specialized and even the stacking of the molds was given deep thought to facilitate pouring-off. As shown in Fig. 1, the molds are set on rails, one row on the two outside rails and two on the center rail which is in the form of a platform and is set up about 12 inches above the two side rails. The aisles extend longitudinally between the rails and when pouring-off the ladle is supported by two men, one on either end of the shank, who pour the metal into four molds across the rails, before proceeding with the next set of four.

As shown in Fig. 5, the rims of the wheels set in spiders which constitute the drag half of the molds. These spiders serve to center the rim and the spokes and are cored-out in the center for the purpose of exactly locating the steel pipe in which are inserted the bushings for the axle and through which the latter extends. At *A* is illustrated the complete drag half of the mold with the rim, to which the spokes are welded in place, as well as the steel pipe in position to receive the cope shown at *B*. A wheel after casting the hub onto the spokes and the pipe for the bearings and axle ready for the final assembly, is illustrated at *C*. It will be noted that two lugs are cast onto the drag spider and also onto the cope flask to serve as bearings for

FIG. 2—THE SMALL, SECTIONAL CUPOLA IN MELTING POSITION. THIS VIEW ALSO SHOWS THE CHARGING PLATFORM AND THE SCALES IN THE FOREGROUND

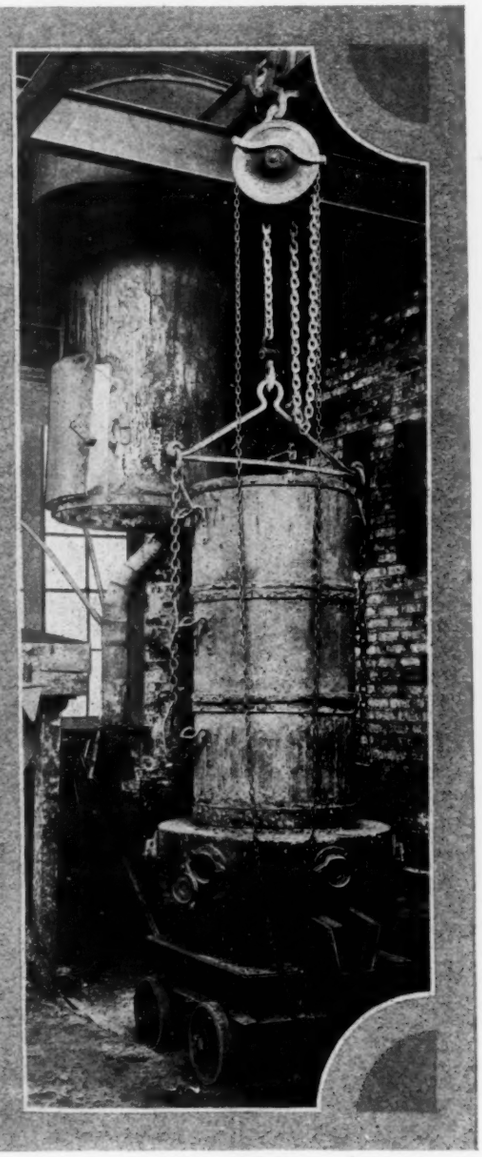


FIG. 3—THE CUPOLA, MOUNTED ON A TRUCK, PULLED FORWARD FOR LIFTING OFF THE SECTIONS FOR REPAIRS

the clamps, the cope being centered by the two flask pins on the drag. All of the flasks are cast iron and are recessed for the spoke bearings, thereby insuring their accurate centering in the hub.

In Fig. 1, at *A* and *B*, are the drag spiders for the large 36-inch wheels shown in Fig. 4. The spokes of these wheels are staggered and the flasks are recessed to insure their proper location; *A* illustrates the drag half of one of these molds and the cope is shown at *B*, while in the background at *C* is a wheel with the hub cast on. In Fig. 1, the spider for the large wheel in the position it assumes for receiving the drag half of the mold is shown at *A*, and *B* is a view of the spider in the reverse position.

Molding Machines

Four stripping plate molding machines are provided for making the molds for all of the hubs, three of these machines being shown in Fig. 6. The two machines at the left make the hub molds for the small wheels, the one on the extreme left having the pattern lowered away, while the one in the center has the pattern elevated in molding position. On the machine at the right are made the molds for the hubs of the large wheels and the contour of the pattern indicates the recesses in the mold to receive the staggered spokes. The steel pipe cast into the center of the hubs is filed off bright to prevent blowing when the molten iron comes in contact with it, but no other precautions are taken to insure the burning-on of the iron to the steel. No coating of any kind is applied, nor is any necessary, since the pipe is absolutely free from rust and scale where it is seated into the hub. Nor is the pipe heated, which is believed by many foundrymen to be a necessary precaution in this kind of work, and the success attained in this foundry with what practically constitutes a burning-on operation proves conclusively that a clean, bright, metal surface only is required to carry out this operation satisfactorily.

Not without interest is the cupola, with its charging platform, which serves this shop. As previously noted, the melting medium is of the baby or experimental type with the stack built in three sections to facilitate repairs and relining since it has a diameter of only 18 inches. The cupola is mounted on a four-wheel truck operating on a track on which it is pushed forward to enable the chain block to lift off the three sections simultaneously. The cupola pulled out from underneath the stack with the bail in position over the three sections, is shown in Fig. 3. Attached to each side of the three sections are handles which are engaged by triangular hooks on the chains to permit of lifting off the three sections simultaneously. The chain block is supported by a trolley on an I-beam. The section of the stack in which the charging door is located is supported from the roof and remains stationary when the cupola is moved out of melting position.

The furnace, which was built by the Northern Engineering Works, Detroit, is shown in melting position in Fig. 2. The joints of the three sections are luted with clay to make them air-tight. In view of the small charges, the scaffold is of proportionate size. A large part of the metal for the heat already is on the platform and the scales at the side of the stairs are used for weighing the charges of iron and coke. The fuel is dumped into the cupola from baskets filled in the yard. In about two hours after the fire is lighted the first metal is tapped and it is as hot and fluid as that obtained from furnaces of a much larger diameter and greater output.

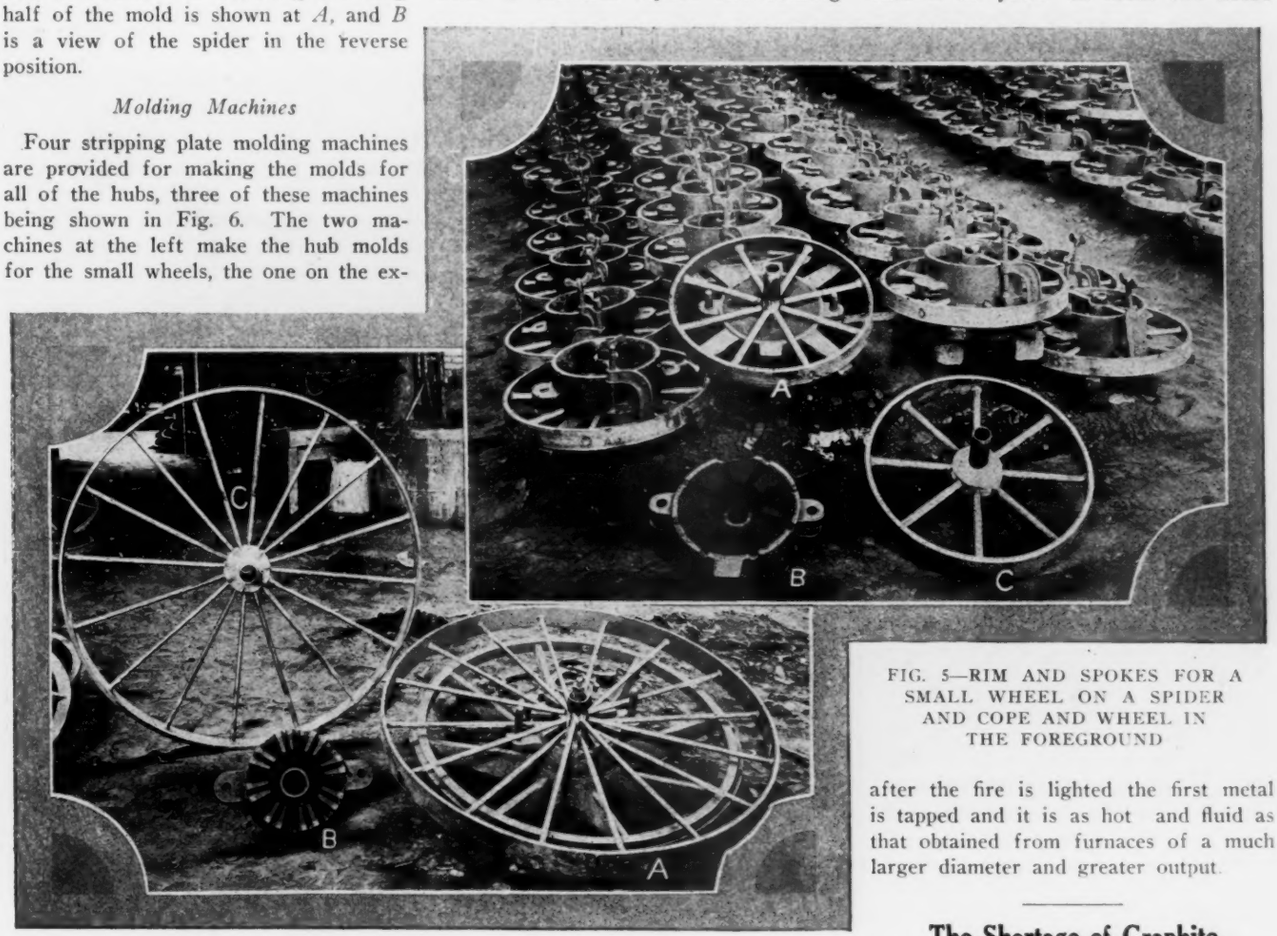


FIG. 4—RIM AND STAGGERED SPOKES OF A LARGER TRUCK WHEEL IN POSITION ON A SPIDER WITH THE COPE IN THE FOREGROUND

FIG. 5—RIM AND SPOKES FOR A SMALL WHEEL ON A SPIDER AND COPE AND WHEEL IN THE FOREGROUND

The Shortage of Graphite

Because of its use in the manufacture of crucibles for melting metals and for foundry facings, graphite is a mineral resource of vital importance and in great demand in time of war. The extraordinary activity both in this country and abroad in the manufacture of munitions has greatly stimulated the graphite industry. Most of the established graphite mines in the Eastern States notably increased their output in 1915, and in the Ashland district, Ala., a number of new mines have recently been opened, most of which have not yet reached the producing stage. Early in 1916 active development work was also begun on a graphite deposit of much promise

in the Llango region, in Texas. The full effect of the increased demands will not be shown until these new concerns begin to market their product, but even in 1915 the output of natural crystalline graphite showed an increase of about 1,850,000 pounds over that for 1914.

Requirements of Crucible Makers

Among the manufacturers of graphite products the crucible makers in particular have greatly increased their output, and many of them have been unable to meet the increased demands because of the difficulty of procuring suitable raw materials, crystalline graphite and refractory clay, in large enough quantities and of satisfactory quality. In spite of the activity among American graphite miners the output of American mines has been wholly inadequate to meet the domestic demands, and in 1915, as in previous years, the greater part of the graphite used in this country came from foreign deposits. In 1915 the graphite imported had a value about four times that of the domestic output of natural graphite. Most of the imports came from Ceylon, but some came from Chosen (Korea), Madagascar, Mexico, and Canada. The imports in 1915 exceeded in value, though not in quantity, those for any previous year and amounted to 23,075 short tons, valued at $2,241,163.

The prices for the better grades of Ceylon graphite increased steadily during 1915 and at the end of the year were nearly twice as much as at the beginning. The high prices are the result of the increased demands, increased freight rates, war surcharges, and higher rates of insurance. At the end of 1915 the freight rates from Ceylon to New York were approximately three times as much as before the outbreak of the war, and early in March, 1916, they had increased to about five and one-half times as much. The lower grades of Ceylon graphite were practically excluded from this market by the demand for the higher grades and the high freights. Madagascar graphite increased in price from about 6 cents a pound at the beginning of the year to 11 and 12 cents at the end. Korean graphite increased from $25 to $40 a short ton, and in March, 1916, its price had reached $50 a ton.

Mexican Graphite

The troublous conditions in Mexico reduced the imports of graphite from that country in 1915 to less than half the amount in 1914. The small Canadian production of graphite was almost entirely absorbed by the United States.

In addition to natural graphite the United States produces large amounts of manufactured graphite in electric furnaces at Niagara Falls. While this material is not suited for the manufacture of crucibles, its manufacture was also stimulated by the European war, because much of it is placed on the market in the form of graphite electrodes used in electric steel furnaces and in other electro-chemical industries.

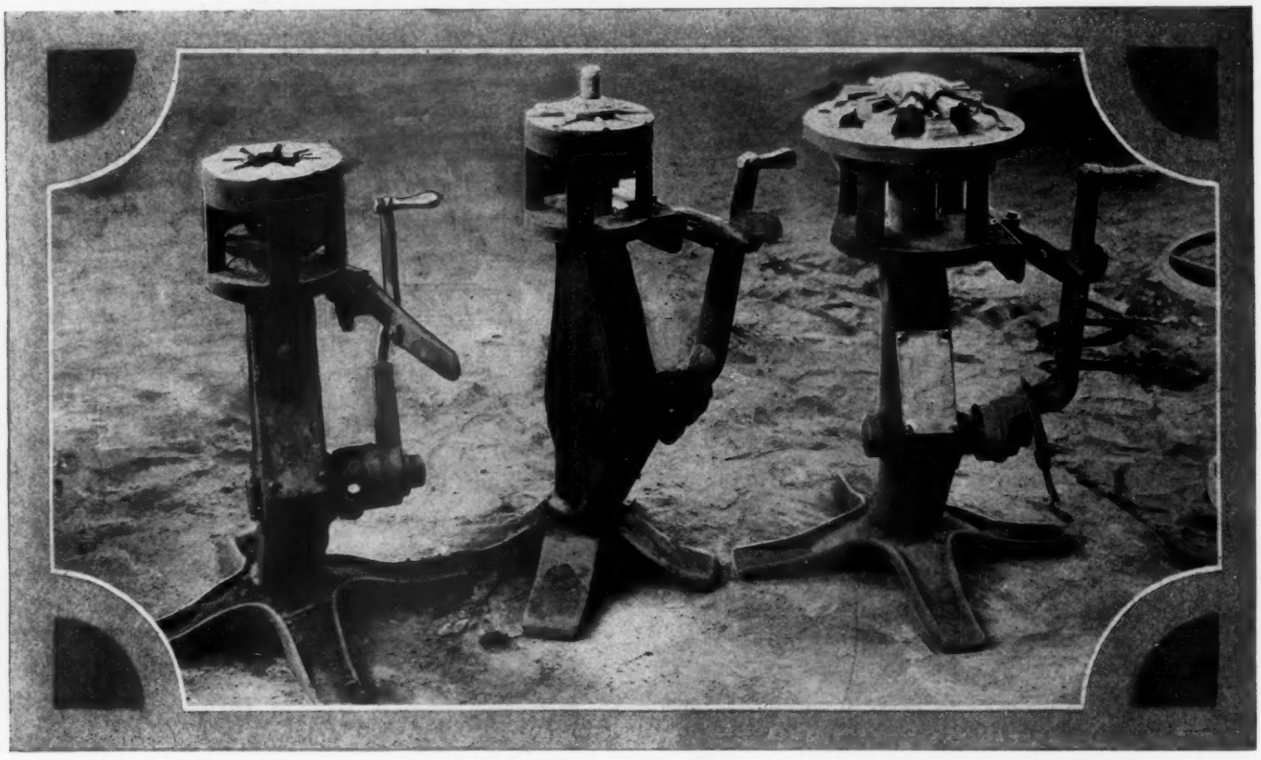


FIG. 6—THREE OF THE FOUR STRIPPING PLATE MACHINES FOR MAKING THE HUB MOLDS

Detroit Foundrymen Banquet and Elect Officers

The annual meeting and banquet of the Detroit Foundrymen's Association was held on the Hotel Tuller roof garden on Wednesday evening, May 10. W. P. Putnam, of the Detroit Testing Laboratory, presided and paid a glowing tribute to the work of the retiring president, A. F. Blackwood, who served in this capacity for two years and due to whose efforts the active membership has been increased to over 250. Mr. Blackwood was presented with a loving cup by the members of the association and he received a silver vase from his general staff.

Officers for the ensuing year were elected as follows: President, Robert Carolin, R. Carolin Co.; vice president, Herbert Osborn, Cadillac Motor Car Co.; secretary, E. W. Kessler, Detroit Steel Castings Co., and treasurer, E. I. Chase, Cadillac Motor Car Co.

The executive committee is constituted as follows: J. W. Collins, Aluminum Castings Co.; W. Bruce Howard, Atlas Foundry Co.; Edward Whittemore, Packard Motor Car Co., and W. A. Fletcher, American Blower Co.

Planning a Foundry From Its Future Operations

How the Architects for the Dodge Bros.' New Casting Plant Figured Every Detail of Work and Equipment Before Designing the Buildings

By E F Lake

A NOVEL method for ascertaining the exact requirements of the new foundry to be erected for Dodge Bros., Detroit, was pursued by the architectural firm of Smith, Hinchman & Grylls, of that city, before the plans were made. The output of the casting plant was to be sufficient to provide the entire gray iron, brass and aluminum parts for the production of 500 motor cars daily and the architects were instructed to spare no expense in the equipment of the plant to effect the greatest economies in labor. Before the foundry was designed the architects were furnished with information covering every pattern for these motor cars that would have to be molded and from this as a basis, data were compiled covering every operation involved in the production of these castings. These included the consideration of the molds and cores to be made, the amount of sand required, the sizes of the flasks, tonnage of sand to be handled, molding machines necessary to produce this work and other equipment to facilitate operations.

All of the data were compiled on two charts, shown in the accompanying illustrations, and after the needs of the plant were ascertained in this way, the shop was designed. Referring to chart No. 1 it will be noted that the pattern number was indicated, as well as the name of the casting, and not only was the kind of metal tabulated from which the various castings were to be made, but the mixture also was indicated. The weight of each casting in the rough also was ascertained and the number of parts required for each car also was given.

Making the Molds

Before figuring on the output it was necessary to ascertain whether the pattern could be mounted on a machine or could be made more advantageously on the bench and the results of this investigation also are shown. The number of pieces one man could make in 10 hours was estimated, as well as the number of castings per floor on a piece-work basis. From this information was ascertained the number of benches or machines required for making sufficient parts for an output of 500 cars daily and the number of pieces per flask also was included. The space to be occupied by the flasks was essential information that had to be compiled and the number of cores for each mold was ascertained, since sufficient floor space had to be allotted for this coremaking equipment and also for handling them economically.

Flasks Required

The number of flasks to be used, with their size, shape and weight was tabulated, since arrangements had to be made to keep the molders constantly supplied with a sufficient number of flasks and space had to be allotted for their distribution on the floors. In addition, the weight of each empty flask was obtained, as well as the weight of the flask ready to pour and after the metal had been poured into the mold. The weight of the sand used for making each mold also was tabulated, as well as the cubic contents of the flasks and the weight of the cores in each flask. It is essential that the cores follow in a steady stream to the molders if the economies planned were to be effected and the building and apparatus had to be designed to insure this result.

To a large extent, it is the custom when designing foundries, to make the output fit the building rather than the building meet the requirements of the output. Frequently it is necessary only to have the foundation sufficiently strong to carry the side walls and roof of the building and this can be estimated easily by the architects or contractors and in many cases a good guess based on experience is all that is required. In many such foundries the cupola and other equipment is on the ground floor and the building is not compelled to carry any of this weight. Occasionally traveling cranes, jib cranes, etc., constitute added equipment and in these instances it is only necessary to make the side walls or columns of sufficient strength to carry the weight of the cranes in addition to the weight of the load lifted.

In recent years, particularly in congested districts where it is necessary to economize ground space, foundry buildings are three, four or more stories high and on each floor sufficient area must be provided for the work of that department. Therefore, it is essential to collect data before designing a building of this kind and in the case of the Dodge Bros. foundry the minutest detail was not overlooked. Furthermore, the question of expansion was one that had to be carefully considered, owing to the fact that the automobile business is undergoing rapid development and an allowance for growth of practically 100 per cent had to be made.

The care exercised in compiling this information is indicated by chart No. 1 and it will be noted that no casting was considered too small to be listed. One of these castings weighs only 0.00392 pound, requiring 257 castings for one pound. One hundred of another type of casting weigh one pound and many other castings weigh less than one pound each. Even the clamps, gaggers, etc., were tabulated and it was found that the total daily weight of the castings alone amounted to 157,437.5 pounds.

Coremaking Data

As shown in chart No. 2, equally as much care was exercised in compiling the data on coremaking. In one case, the weight of an individual core is given as 0.02 pound and 50 of these would be required to total one pound. Two other small cores weighed 0.03 pound each, four others 0.06 pound, one 0.07 pound, one 0.08 pound, ten 0.125 pound, five 0.25 pound, while many others weighed less than one pound each. The sand required for the cores to insure a daily casting output for 500 motor cars aggregated a total of 260,181 pounds. In referring to chart No. 2 it will be noted that the data covering cores included the kind of metal from which the casting was to be made, the weight of the core, the number per casting and the number one man could make in an hour. The output for an eight-hour and a 10-hour day to cover the requirements of 500 automobiles also was ascertained, as well as the number of coremaking benches and machines to be installed. The question of binders was not overlooked and

the sand mixture also was included. It will be noted that every core is carefully indicated as to the nature of its binder, whether oil, flour, rosin, etc. Core plates were not overlooked followed with the work to be done on the core before baking, between bakes, in assembling and data on the work to be done after the final baking and assembling. The time required

Each room in the architect's office was furnished with a set of these tables for ready reference. They proved of great value to those who had to figure out, plan and design the ma-

No. of Casting	Name of Casting	Kind of Metal	Kind of Mixture	Weight of Rough Casting—Pounds	No. of Pieces Required Per Car	Bench or Machine Made	No. of Pieces One man can make in 10 hours	Weight of Machines Necessary to make 500 Good Castings—Pounds	No. of Pieces per Flask	Index of Cores Used	Weight of Molding Sand per Flask—Pounds	Weight of Cores per Flask—Pounds	Size of Flask Inside Dimensions—Inches	Weight of Empty Flask, Clamps, Etc.—Pounds	Weight of Flask Ready to Pour—Pounds	Weight of Flask Poured Pounds	No. of Flasks for 500 Cars	Weight of Molding Sand for 500 Cars—Pounds	Cubic Contents of Flasks for 500 Cars—Feet	
A2214	Cylinder	Iron	Cylinder	156	One	Machine	170	3.0	1	1-23-11-12-14-16-17	445	375	24x32x18	340	1160	1326	500	222,500		
A-186	Cylinder Head	"	"	39	"	"	80	7.0	1	18-27-29	202	11.3	12x20x13	117	330	380	500	101,000		
A-221	Fly Wheel	"	Fly Wheel	72	"	"	72	7.0	1	26	23-25-26	103	2.5	20 Dia x 10	90	250	340	500	81,500	
A-351	Exhaust Manifold	"	Soft	8½	"	"	140	4.0	2	15			6.0	14x28x10	100	307		250		
A1993	Piston	"	Cylinder	6	Four	"	390	6.0	4			61		10x24x11	191	252	285	500	30,500	
A1929	Gear Case Cover	"	"	18	One	"	80	7.0	1	132			0.5	14x18x14	125			500		
A2788	Valve Head	"	"	7/8	Eight	"	3000	2.0	30					14x16x8	100			134		
A2617	Valve Lifter Guide	"	Soft	7/8	"	"	2500	2.0	22	Stock Core 2¼x2¼				14x16x8	100			182		
A-219	Chain Inspection Cover	"	"	1½	One	"	300	1.0	4			90		14x18x8	95	185	200	125	11,250	
A-256	Water Pump Body	"	"	3	"	"	170	3.0	2	4-7		68	3.2	12x14x9	92	162	175	250	17,000	
A-258	Water Pump Cover	"	"	1 3/16	"	"	400	2.0	4	5-8		93	2.0	12x18x8	145	240	255	125	11,025	
A-285	Water Inlet Ell	"	"	1/4	"	"	900	1.0	8	10			4.0	14x10x8	100			63		
A-339	Cylinder Valve Plate Stud Nut	"	"	1/4	"	"	2200	1.0	20									25		
A1299	Starter Button Rod Bushing	"	"	1/8	"	"	2500		25	Stock Core ½x¼"								20		
A1702	Oil Pump Body	"	"	3/8	"	"	275	2.0	8	9			2.0	12x18x8	145			63		
H1942	Water Pump Gear Cover	"	Cylinder	3	"	"	530	1.0	4			90		16 Dia. x 8	100	190	210	125	11,250	
A1969	Fan Pulley	"	Soft	1½	"	"	500	1.0	4					14x16x8	100			125		
J-490	Front Hub Cap	Aluminum	No. 12	Not Including Gates 0.279	Two	Machine	Pieces Made Per Hour 590	1.7	8	1A		715	7	12½x18x6	125	203.3	208.0	65	4,645	31
J-491	Rear Hub Cap	"	"	0.334	"	"	1000	1.0	14	1A		60.5	12.25	12½x18x6	"	197.75	203.4	36	2,359	28
C-341	Steering Wheel Spider	"	"	1.205	One	"	135	3.7	1			50		12x12x6	100	150.00	152.0	300	25000	2.50
L-1188	Door Lock Lever Handle	"	"	0.0375	Four	"	4000	0.5	60			76		12½x16x6	125	203.0	206.0	9	700	7
A1310	Oil Level Indicator Button	"	"	0.00392	One	"	15600	0.032	92			76		12½x18x6	"	"	205.0	3	234	2.34
A1548	Oil Pan	"	"	22.5	"	"	135	3.7	1	2A-11A-12A-13A		1070	9.56	24x40x19½	325	1404.6	1429.0	300	335220	5400 Made in Halves
B-1581	Clutch Cone	"	"	4.128	"	"	89	5.6	1	9A		88	0.48	16x16x6	100	186.5	193.5	"	44340	4.45
A-1707	Crankshaft Rear Bearing Oil Retainer Flange		"	0.01	Two	"	780	1.26	14			78		12½x18x6	125	203.0	204.0	36	2,800	28
A2422	Breather Pipe	"	"	0.625	One	"	356	1.45	2	3A		75	2.50	12½x18x6	125	200.0	202.0	250	18,875	195
B2491	Transmission Case	"	"	28.5	"	"	139	3.6	1	3A-5A-6A-7A-8A-10A		1068	7450	24x33x25	325	1467.5	1498.0	500	534250	5,725 Made in Halves
A2640	R.H. for A1546							152#								4423.65		2999	1,168,423	
B2638	R.H. for B2491																			
	Total Aluminum For 1 Car = 58,433 Pounds																			
B-27	Reverse Idler Gear Bushing		Phos Bronze	0.256	One	Machine	2670	0.187	36			79		12½x18x6	125	204	276.0	14	1100	11
H-96	Differential Cross Bushing		" "	0.662	"	"	1780	0.28	26			78		"	"	203	224.0	20	1560	15.6
E-167	Front Axle Spindle Bushing		x Bronze	0.269	Four	"	2560	0.78	36			79		"	"	204	276.0	14	1100	11
E-178	Front Axle Steering Arm Bushing		"	0.127	Two	"	3340	0.29	50			78		"	"	203	215.0	10	780	7.8
A-210	Oil Pump Shaft Bushing		"	0.92	One	"	2670	0.161	36			79		"	"	204	240.0	14	1100	11
J-233	Rear Spring Bushing Front		"	0.219	Two	"	2220	0.45	30			80		"	"	205	213.0	17	1360	13.6
J-234	" " " Rear		"	0.19	Four	"	3110	0.55	42			78		"	"	203	213.0	12	940	9.4
A253	Water Pump Rotor		Welfind Brass	0.613	One	"	334	1.5	6	18-28		77	6.24	"	"	206.5	214.0	84	6046	65.7
A263	Connecting Rod Bushing Upper		Phos Bronze	0.312	Four	"	2450	0.82	32			77		"	"	202	218.0	16	1250	12.5
A275	Water Pump Packing Gland		x Bronze	0.2	Two	"	3900	0.26	52			78		"	"	203	219.0	10	780	7.8
A280	" " " " Nut		"	0.188	One	"	3110	0.161	42			69		"	"	194	204.0	12	835	8.35
H299	Front Spring Hanger Bushing Rear		"	0.214	Two	"	2330	0.43	32			78		"	"	203	213.0	16	1250	12.5
C-330	Steering Gear Screw Bushing		"	0.394	One	"	1670	0.3	25			78		"	"	203	215.0	20	1560	15.6
C-335	Steering Gear Nut		"	2.365	"	"	667	0.75	12			93		12½x16x6	100	193	229.0	42	3920	39.2
B-400	Clutch Shaft Bushing		Phos Bronze	0.212	"	"	2670	0.187	36			79		12½x18x6	125	204	213.0	14	1100	11
B-427	Transmission Countershaft Over Bushing		" "	0.332	Two	"	2450	0.41	32			78		"	"	203	219.0	16	1250	12.5
A443	Crankshaft Bearing Shell Center		Welfind Brass	0.83	One	"	667	0.75	10			78		"	"	203	213.0	50	3900	39
A444	" " " " Front		" "	0.902	"	"	735	0.68	10			78		"	"	203	214.0	50	3900	39
A445	Connecting Rod Bearing Shell		" "	0.673	Four	"	835	2.4	12			78		"	"	203	212.0	42	3280	32.8
C484	Steering Wheel Shaft Bushing		x Bronze	0.455	One	"	1450	0.34	22			76		"	"	203	214.0	23	1800	18
J-550	Front Spring		" "	0.1685	Four	"	2210	0.95	32			77		"	"	202	210.0	10	1250	12.5
B-559	Transmission Control Lever Nut		"	0.2815	One	"	1670	0.3	22			78		"	"	203	213.0	23	1800	18
A571	Oil Pan Strainer Flange		Welfind Brass	0.419	"	"	1560	0.32	26			78		"	"	203	216.0	20	1560	15.6
A624	Water Pump Body Backing Nut		"	0.1895	"	"	3120	0.16	42			78		"	"	203	213.0	12	940	9.4
R627	Differential Pump Bushing		x Bronze	0.149	Four	"	3320	0.6	50			76		"	"	203	213.0	10	780	7.8
A634	Motor Fan Pulley		"	1.66	One	"	555	0.9	10	3B		77	1.25	"	"	202	222.0	50	3838	39
H-698	Spark and Throttle Control Sector		Welfind Brass	0.693	"	"	445	1.12	6			78		"	"	203	209.0	84	6570	65.7
Z800	S.A.E. Flared Tube Bell Bolt		"	C 1025	"	"	5550	0.09	66			78		"	"	"	203.0	74	5780	57.8
B1053	Speedometer Gear Support		x Bronze	0.423	"	"	1000	0.5	14			78		"	"	"	210.0	36	2800	28
B1099	Clutch Hub Grease Tube Flange		Welfind Brass	0.116	"	"	5550	0.09	82			78		"	"	"	219.0	7	550	5.5
A1472	Air Pump Body		x Bronze	0.965	"	"	835	0.6	12			78		"	"	"	216.0	42	3280	32.8
A1618	Water Pump Magneto to Drive Shaft Bushing Front		"	0.218	"	"	1835	0.272	26			78		"	"	"	210.0	20	1560	15.6
A1619	" " " " " Front		"	0.218	"	"	1835	0.272	26			78		"	"	"	210.0	20	1560	15.6
A1620	" " Shaft Bushing Pack Nut "		Welfind Brass	0.135	"	"	4675	0.107	62			78		"	"	"	215.0	9	700	7
A1621	" " " " " Rear		"	0.135	"	"	4675	0.107	62			78		"	"	"	215.0	9	700	7
A1770	Carburetor Strangle Valve Handle		"	0.054	"	"	3320	0.15	48			78		"	"	"	208.0	11	860	8.6
A1807	Crankshaft Bearing Shell Rear		"	0.855	"	"	722	0.95	10			78		"	"	"	213.0	50	3900	39
A1892	Oil Pump to Motor Oil Pipe Tee		"	0.115	"	"	4450	0.112	68			78		"	"	"	215.0	8	625	6.25
A1893	Oil Pump Pipe Ell		"	0.180	"	"	3540	0.14	54			78		"	"	"	213.0	10	780	7.8
Z2007	S.A.E. Flared Tube Ell		"	0.110	"	"	6225	0.08	74			78		"	"	"	217.0	7	530	5.5
C2395	Steering Gear Adjusting Screw		x Bronze	0.975	"	"	1335	0.37	20			78		"	"	"	223.0	3	234	2.34
C2546	Steering Arm Shaft Bushing		"	1.2638	"	"	445	1.12	8			78		"	"	"	219.0	63	4900	49
A2825	Oil Line Check Valve Body		Welfind Brass	0.188	"	"	1560	0.32	26			69		12½x16x6	100	169	175.0	20	1380	13.8
	Total Brass For 1 Car = 25,507 Pounds							21.29								8486.5		1100	85708	

CHART NO. 1—TABULATED DATA ON IRON, BRASS AND ALUMINUM CASTINGS TO BE MADE IN DODGE BROS.' NEW FOUNDRY

and the number of cores that each plate would hold, the size and weight of the plate, the weight of the dryer and the weight of the plate when loaded with wet cores were tabulated. This was for the first and second bakes, for cooling, together with the weights of the cores and plates when dried by baking, as well as other details were ascertained.

and the number of cores that each plate would hold, the size and weight of the plate, the weight of the dryer and the proved as valuable to those who laid out the equipment as well as the de-

signer who prepared the plans for the building.

This foundry is to be a four-story building, the gray iron shop to be located on the ground floor, the core shop on the second floor, the core ovens on the third floor and the aluminum, brass and bronze foundry will be located jointly on the second cores thus being delivered into one end of the oven. The conveyor then passes through the bottom of the oven to the floor underneath where the cores are removed for the necessary work that must be done on them between baking operations. They are then loaded onto the conveyors again for the second baking, passing through continuous ovens for drying. The baking time will be governed by the speed of the conveyor and the length of the ovens. Two core ovens, 70 feet long, have been designed for baking cores in one-half and three-quarters of an hour, respectively, while two other ovens, 100 feet long, will bake cores in one hour and one, one and three-fourths and two hours and eight ovens with slow traveling conveyors, 38 feet long, each will bake cores in three, four and five hours, respectively. The ovens will be provided with the necessary equipment to insure accurate and uniform temperature control.

Wherever possible, labor-saving equipment will be installed in this foundry and all of the sand will be cut-over, mixed, screened, etc., and delivered to the coremakers and molders without the necessity of hand-cutting or tempering. Finished cores also will be handled by conveyors from the coremakers to the molders and castings will be conveyed to the cleaning room and will be handled in the tumbling barrels, sand-blast, etc., with a minimum of hand labor. Throughout the foundry, machinery will be installed for every possible operation.

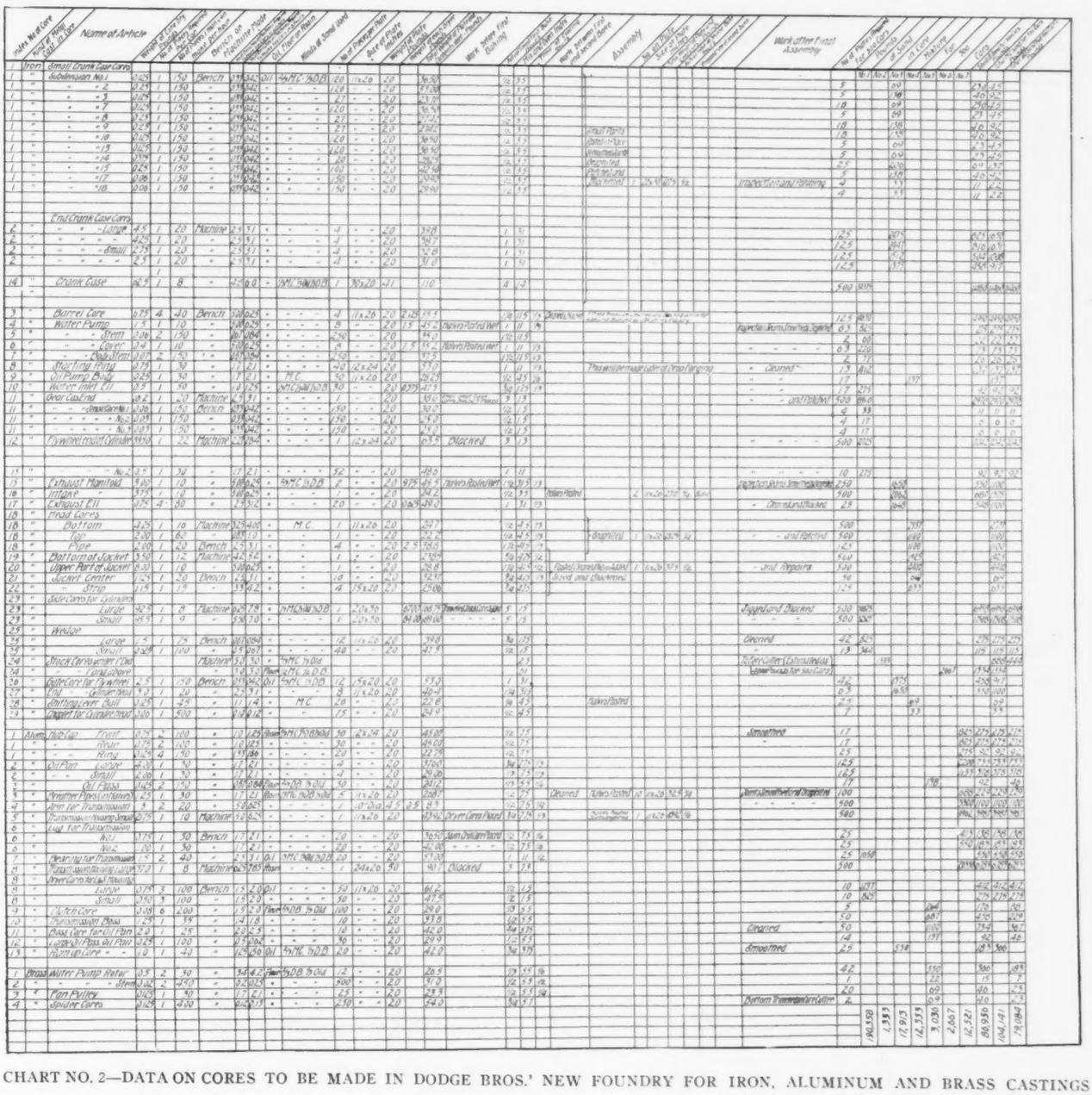


CHART NO. 2—DATA ON CORES TO BE MADE IN DODGE BROS.' NEW FOUNDRY FOR IRON, ALUMINUM AND BRASS CASTINGS

and third floors. The sand for molders and coremakers will be elevated to the top of the building, where it will be cut-over and otherwise prepared for use. By conveyors, the sand will be distributed to the core department and to the molders' benches. The cores on the plates are next elevated through the bottom of the core ovens located on the floor above the coremaking department, the

Reclaiming Molding Sand in an Eastern Plant

Description of a Simple and Practical Method Devised for the Recovery of a Large Percentage of Waste Sand

By W M Saunders and H B Hanley

FOUNDRYMEN have long recognized the need of some way of reclaiming, or bringing back to its former condition, used molding sand. In some localities this need has not been so apparent as in others where the first cost of the sand and the cost of removing waste have been exceedingly high. Not only the reciaming of old sand appeared important but keeping the sand in actual use in good condition became an attractive proportion. Many investigations and experiments have been made with the view of improving and reclaiming molding sand. Some of the results of these investigations were considered of enough value to protect the process by patents. Patents have been issued for machines to be used in treating and tempering molding sand, also for the addition to the molding sand of various chemicals tending to improve the molding qualities of the sand. In some of these patents it was claimed that certain chemicals would restore that property which the sand lost when heated in contact with molten metal.

What takes place when molding sand is heated is not definitely known, but one result is of importance to foundrymen, that is, the loss of bonding power. Molding sand heated a little above the temperature of boiling water loses very little bonding power. As the temperature to which the sand is exposed is increased a greater loss takes place until at the temperature of red hot metal the bond is destroyed and the sand no longer posseses the property of molding sand.

The loss of bonding power is well illustrated by the following experiment: Molding sand having a bond expressed by the number 480 was heated for the same length of time at different temperatures. The result of the heating was to reduce the bonding power as shown in the following table:

Heated at Deg. Cent.	Bonding Power, No.
100	480
300	380
500	260
700	260
900	160
1000	120

Heating for a longer period at 1,000 deg. Cent. caused the complete destruction of the bond.

Presented at the Atlantic City meeting of the American Foundrymen's Association.

It is evident that all molding sand in contact with very hot metal loses bond, and the longer the time required for cooling the casting the greater the penetration of heat into the sand mold, and consequent large loss of bond. For this reason it is desirable to remove the castings from the sand as soon as all danger of too sudden cooling has passed.

The bonding property of molding sand is due to the amount and quality of the clay contained therein. In determining the bond of molding sand advantage is taken of the well-known fact that clay has the property of adsorbing various dyes, the amount adsorbed depending upon the quality of plasticity of the clay. Hence, in molding sand the greater the plasticity and bonding power of the clay present the larger the amount of dye adsorbed.

Probably the earliest investigator to recognize the value of dye adsorption applied to molding sand was Dr. Moldenke. The result of his extensive work has been published in *Transactions* of the American Foundrymen's Association, Vol. 21, 1913.

Molding Sand Tests

There are three important tests to be used in studying the value of molding sands: Rational analysis, mechanical analysis and bond test, as indicated by the dye adsorbed.

The rational analysis consists of treating the molding sand in a manner to show the amount of quartz, feldspar and clay substance contained. The mechanical analysis consists in separating the molding sand into various sizes, held on sieves of increasing fineness, and is usually expressed in percentage held on the different mesh sieves. The bond test consists of treating the properly prepared molding sand with a dye dissolved in water, and the result expressed as milligrams of dye adsorbed by 100 grams of the sand. The mechanical analysis and bond test as employed by us will be described later in this paper. A method for the rational analysis has been described by Dr. Moldenke.

For the purpose of restoring bond to molding sand by the means of clay, we have been carrying on experiments for about three years. The experiments were made in a large foundry employing molding machines making pipe fittings. The molding sand from the state of New York was known as North river sand, and had the following mechanical analysis and bond test:

Mesh.	Percentage.
20	0.09
40	1.69
60	11.47
80	13.39
100	7.08
150	22.84
200	9.14
200+	17.32
Clay sub.	16.92

Bond test 500.

The foundry was constructed after the two-story style, the castings being shaken-out onto a grating through which the molding sand passed to the floor below to be mixed with new sand, tempered and returned by means of conveyors to the molding machines. The castings, with sprues and adhering sand, were picked up from the grating and dropped through a chute to the floor below. Considerable adhering sand was rubbed off the castings in passing through the chutes, and accumulated on the floor at the bottom of the pile of castings. This burned and waste sand having a bond of less than 100 was reclaimed and added as new sand to the molding sand being used.

The method of reclaiming this burned and waste sand was as follows: The sand was first passed through a sieve to remove pieces of iron. It was next mixed with New Jersey fire clay having a bond of about 2,500, in the proportion of three parts of burned sand to one part of clay. This 25 per cent clay mixture was then passed through a grinder, not for the purpose of making it finer, but to thoroughly mix the clay and sand by rubbing the particles together, and thus bring them in contact. By means of this it was believed the clay would cover and adhere to each grain of sand, replacing the bond destroyed in the original molding sand. A new molding sand was thus made having a bond of about 600 to be used in place of natural molding sand. No other molding sand but this reclaimed sand was used by a number of molding machines for several months.

Mechanical analyses made upon samples taken from the sand used on

a molding machine making 2-inch elbows at the beginning of the experiment and at the end of one month, three months and six months after, gave the following texture and bond:

Mesh.	Beginning, per cent.	One month, per cent.	Three months, per cent.	Six months, per cent.
20	1.80	2.08	2.72	2.22
40	5.78	4.60	7.20	6.50
60	11.40	10.80	11.32	11.37
80	11.44	12.32	11.50	10.64
100	6.04	5.88	6.62	5.90
150	21.33	23.16	20.88	21.20
200	9.77	9.06	8.44	9.23
200+	19.16	18.52	17.40	17.40
*	13.28	13.58	13.92	15.54
†	304	336	344	312

It was found that the quality of the clay used for bonding should be suitable for mixing well with the waste sand, have high plasticity as indicated by the bond test, and be as highly refractory as possible.

Later experiments showed the ground New Jersey fire clay possessed properties which made it possible to be mixed as a bonding clay with the waste sand by means of shovel and riddle, the grinder being unnecessary.

No attempt was made to clean the burned or waste sand by removing the finer portions, as the coarser bank sand carried into the molding sand by cores helped to keep in balance the fine clay material.

To make the mechanical analysis, 25 grams of molding sand are placed into a 500cc. wide-mouth glass-stoppered bottle, and 300cc. of water are added. A deflocculating reagent is next introduced into the bottle. For the purpose sodium hydroxide, sodium carbonate and ammonium hydroxide are very well adapted.

Molding sands from various parts of the United States are affected differently by the kind of deflocculating reagent employed. Sands from Ohio and Kentucky are deflocculated best with sodium hydroxide, New Jersey with sodium carbonate and New York with ammonium hydroxide. A few preliminary tests on a sand from an untried district will soon indicate the reagent best suited for removing the clay, and separating the sand into its individual grains.

The deflocculator selected should be added in very small amounts, namely, 50 milligrams in case of sodium hydroxide; 200 milligrams of sodium carbonate; or 2.5cc. of ammonium hydroxide, sp. gr., 0.90.

The glass stopper is then put in its place in the bottle, sealed with paraffine wax, and the whole rotated on a machine making about 60 revolutions per minute. The bottle being inverted at every revolution a complete agitation is imparted to the sand. After rotating for one hour the contents of the bottle are emptied and washed onto the first and coarser of a series of standard sieves in the following order: 20, 40, 60, 80, 100, 150 and 200 meshes per inch. A jar holding about one gallon directly below the lower or 200-mesh sieve receives the finer portion along with the clay substance. The washing of the sand through each sieve is carried on by using a stream of water possessing sufficient force and volume to carry the smaller particles through the larger meshes until they reach the proper sieve or pass into the jar below. Without removing the first or 20-mesh sieve from the nest it is washed with the stream of water until all the material capable has passed to the next sieve. It is then placed to one side and the 40-mesh is treated in the same nanner, and so on, until the contents of all the sieves have been thoroughly washed. Each sieve is then wet with alcohol, dried at 100 degrees Cent. and the sand transferred to a watch glass and weighed. The fine material in the jar is allowed to remain undisturbed for five minutes, then the clay substance decanted off. Water is added to the jar, the suspended particles decanted off after remaining undisturbed for five minutes, and this repeated until the added water remains clear. The material remaining in the jar is designated as 200 plus mesh. This is collected on a filter paper, washed with alcohol, dried and weighed. The clay substance is obtained by subtracting the sum of the percentage of all the other sizes from 100 per cent.

Bond Test

In making the bond test, 25 grams of the molding sand are placed into a 500cc. wide-mouth bottle fitted with a glass stopper, and 250cc. of distilled water and 5cc. of 10 per cent ammonium hydroxide are added. The bottle is then stoppered, sealed with paraffin wax, and placed in the rotating machine for one hour. At the end of this period 140cc. of distilled water are added to the bottle and also sufficient acetic acid to neutralize the alkali and leave a slight excess of acid to flocculate the colloidal matter, usually 5cc. of 10 per cent acetic acid being required. Crystal violet dye is then added in sufficient weight to allow for the adsorption by the colloidal matter and leave a slight excess. The bottle is then sealed and placed in the rotating machine for two hours. If all the dye is taken up by the colloidal matter then a small weight of dye should be added, and the rotating continued.

In order to determine the amount of dye adsorbed by the sand it becomes necessary to find the quantity unadsorbed or held in solution. This can be done in comparison tubes by comparing the depth of color of the water solution with a standard color solution made from a known weight of dye. Unfortunately, considerable suspended matter remains in the supernatant liquor containing the unadsorbed dye, and prevents accurate comparison. The dye can be completely taken out of solution by means of mordanted cotton yarn.

After removing the bottle from the rotating machine it is allowed to stand for a few hours until the coarser particles have settled to the bottom; 100cc. of the supernatant liquor is transferred to a beaker, 25cc. of water and 2cc. of 10 per cent acetic acid added. The beaker is placed in a water bath at room temperature, and a five-gram skein of mordanted cotton yarn introduced into the solution. The skein is worked for 20 minutes, then for another 20 minutes the temperature of the solution is slowly raised to 60 degrees Cent. while working the yarn. The dyeing of the skein is completed in 20 minutes more, working with the temperature of the solution at 60 degrees Cent. All the dye should be removed from the solution, the suspended matter from the molding sand remaining behind. The skein is then washed and slowly raised to 60 degrees Cent. Comparison of the color on the skein is made with standard skeins, a set of which is kept preserved in the dark. The standard skeins are prepared by depositing upon each, in the manner described, 6, 8, 10, 12, 14 and 16 milligrams of crystal violet.

Another two-ton Open-Hearth to be Installed

The Gas Traction Foundry Co., Minneapolis, which operates a large gray iron and brass foundry, has placed an order with David McLain, Goldsmith building, Milwaukee, for the installation of a two-ton open-hearth furnace which will have an output of five heats or 10 tons in 12 hours. The first furnace of this type built by Mr. McLain now is in operation at the plant of the Standard Crucible Steel Casting Co., Milwaukee, and since the first steel was made in March 248 heats have been cast without making repairs of any kind to the roof or relining. At this plant four or five heats are made daily, the metal being poured into castings of varying weights from a few ounces to 1,000 pounds.

A Short Cut in Welding Rolling Mill Pinions

Details of a New Wax Process, Which Combined With Thermit, Can Be Employed for Repairing Large, Intricate Castings

THE proper shaping of the wax pattern for welding broken teeth in rolling mill pinions by the thermit process is one of the most important operations in the whole repair, if not the most important, it is stated by F. N. Keithley in a recent number of *Reactions*, issued by The Goldschmidt Thermit Co., New York. The new tooth must mesh properly or the entire repair will have been made in vain. This meshing is dependent on the proper placing and form of the wax pattern.

Up to the present time the usual procedure has been to construct a rough wooden box a little larger than the tooth to be welded, placing it against the pinion where the new tooth is to be added, and luting around the edges with fireclay. This box is then completely filled with molten wax and when the wax has set, the box is removed and the wax pattern brought to proper form by means of a template. This template is usually made from ⅛-inch steel plate and the outline of three teeth cut into it by using three good teeth in the pinion as a guide. The center tooth, however, which represents the guide for the tooth to be welded is cut 1/32-inch larger all around so as to allow for the contraction of the thermit steel tooth.

The two outside teeth of the template can then be engaged with the teeth on each side of the wax pattern, and when the template is moved up and down it will cut the wax to proper shape making it certain that the new tooth will be welded-on in proper pitch.

New Method Devised

This method has proved very satisfactory in practice, but is open to the objection that if the teeth of the pinion are worn irregularly the template method does not take care of these irregularities. For instance, the template represents the shape of the adjacent teeth at one point only, while perhaps at some other point there may be greater wear. It was to improve this condition and at the same time devise a method which would save considerable time in making these repairs that a new method of making wax patterns was developed. Briefly, this method consists of making a sand mold for casting the wax pattern, using the adjacent good teeth in the pinion as models to go by.

Referring to the accompanying illustrations the pattern shown in Fig. 4 should be made and fitted as indicated, after which sand should be properly mixed for cores, using two parts of building sand to one of fireclay. This should be sifted through a No. 4 mesh riddle and should then be moistened a little more than would be necessary if it were to be used in ramming a mold. If this mixture does not draw well, more clay can be added, as the clay will not affect the wax in any way.

The pinion should then be placed in a horizontal and level position with the missing tooth section in the center of the upper part. The core can then be rammed, after first thoroughly cleaning between the teeth which are to be used as the guides. They should be nearest the top.

The pattern is then placed in the bottom of the space between two teeth and held with lag screws, after which the core is rammed firmly to a point ¾-inch above the height of the tooth, as indicated in the accompanying illustrations. The most convenient way to do this is to place an iron or wooden strip ¾-inch high on the top of the tooth. The core should be slicked from this height to the level of the opposite tooth. The purpose of providing the extra height is to hold enough wax for shrinkage.

After the core is thoroughly rammed it should be carefully drawn by two men using the end lag screws, Fig. 6, for the purpose. It should then be set carefully on a box wide enough to support it over the entire length. It is advisable to force a little sand under it in order to keep the core stationary. Two cores are necessary to make one tooth and the second core is made in exactly the same way as the first.

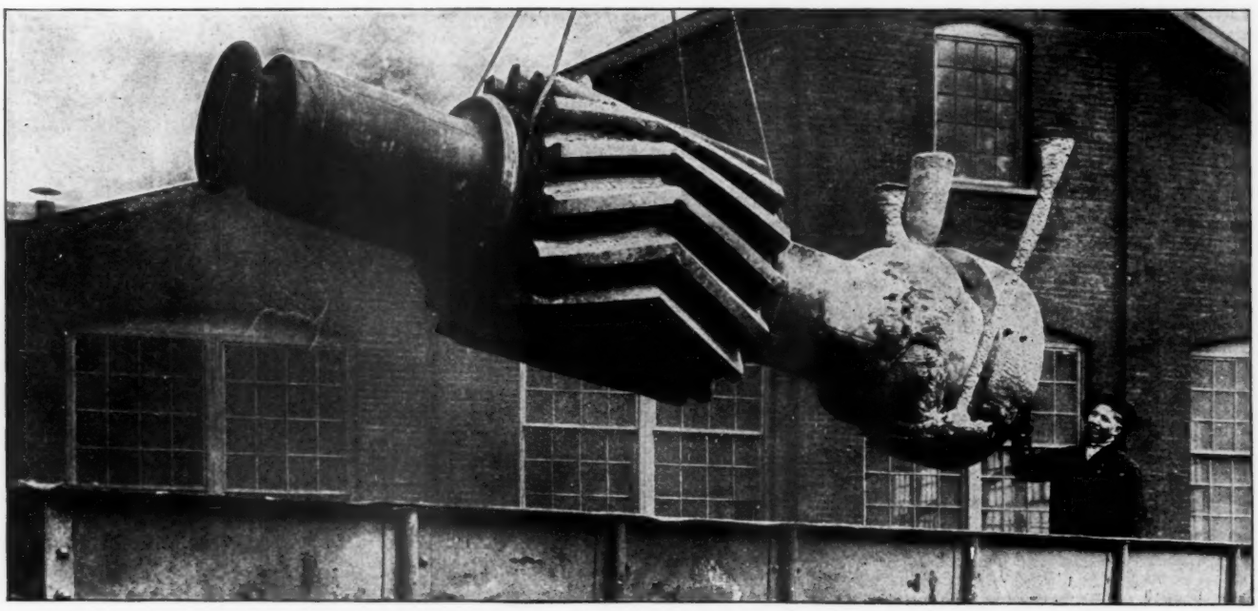


FIG. 1—SLAB MILL PINION SHOWING CHARACTER OF TEETH IT FREQUENTLY IS NECESSARY TO WELD

When both are ready the operator should start at one end of a core and remove ¼-inch from top to bottom over the entire surface. After this has been done, the surface should be slicked to make it smooth and marked so as to be sure of placing it in its proper position. It should be understood that this sand is removed from the side of the core which does not come in contact with the wax. The object of this cutting is to make the mold slightly larger to take care of the shrinkage of both the wax and thermit steel.

The cores can now be placed in position, one on each side of the missing tooth, making sure that the sides of the core from which the ¼-inch has been removed are resting tightly against the adjacent teeth. A weight should then be placed partly on adiacent teeth and partly on the core to hold it in correct position. The end can then be stopped-off with fireclay mixed to the consistency of putty. The mold can be filled with small pieces of wax about 1 inch square, after which melted wax can be poured in, thus filling up all spaces between the small pieces of wax.

Care should be taken not to have the wax too hot, as it is only necessary that it should be hot enough to run freely. If it is boiling hot it will tend to eat into the sand and make a rough tooth.

The mold should not be disturbed until the wax has set, which will be from three to four hours after pouring. In the meantime, however, other work can be done, such as mixing sand for the mold, assembling the mold box, etc.

Shrouded Pinion

If the pinion is shrouded, the wax pattern to provide the thermit steel reinforcement on this shroud can be put on at the same time that the wax tooth is formed, it being only necessary to roll a long clay rod about 1 inch in diameter and lay it against the pinion 3 inches away all around from the space cut through the shroud, then back-up with a board large enough to extend above the top of the tooth.

This board can be held in place with two C-clamps and luted with clay between board and cores on the inside so that the wax will flow to its proper level. This is shown in Fig. 3.

This work is all done in green sand, and if care is taken while making the pattern for the new tooth with this method there will be very little finishing on the wax, thereby effecting a saving of about two days on each welded tooth, not to mention the added advantage that the new tooth will be welded on in proper pitch and will have the exact form of the other teeth in the pinion, thus eliminating any undue strains when the pinion is placed in service.

Bushing Grinding Wheels

In a recent issue of *Grits and Grinds*, published by the Norton Co., Worcester, Mass., the bushing of grinding wheels is discussed at length. It is pointed out that while it is of the utmost importance that grinding wheels should be properly bushed, very crude and inefficient methods are in use in many plants and it is not surprising that grinding wheel troubles result.

Lead can be judged by the color. Soft pig lead has a greenish purple tinge when hot. This is too soft for the bushing to retain its shape, and it will not stand careless handling when placing on a machine spindle. Frequently, the complaint that a wheel is "out of truth" is caused by the bushing being too soft. The lead when hot enough to bush with should be of a grayish color.

Babbitt is a much harder metal and, therefore, better adapted for bushing cup wheels with large overhang. Very coarse wheels that are subjected to hard pressure on the periphery, stand up much better if bushed with babbitt.

It is advisable to remove the blotters from the sides of the wheel before bushing. If this is not desireable, make a paper collar the same thickness as the blotters and small enough to go inside of a hole in blotters and fit on the arbor. This will keep the new lead bushing even with the old one and will save trouble from the wheel running out on the sides. It is also advisable to put two or three notches in the old bushing, with a hammer and chisel, to make the new lead unite more securely with the old.

When wheels are not properly bushed, they will run out of truth on the sides, which indicates that the hole is not at right angles with sides of the wheel. In mounting the wheel, a careless operator might not notice such a condition and tighten the wheel up against the stationary flange on his grinding machine spindle. Usually this breaks the wheel, but if it does not, the wheel is very liable to break when it comes in contact with the work. It is more dangerous when the wheel does not break when mounting, as placing it in contact with grinding work places extra strain on it and the wheel breaks when revolving.

Another cause for breakage, at times, is a bushing left sticking out on the sides of grinding wheels. It is important that the lead bushing does not protrude outside of the wheel. It is, therefore, necessary to trim off the bushing with a chisel even after a cleaner has been used as the lead will sometimes be above the side of the wheel.

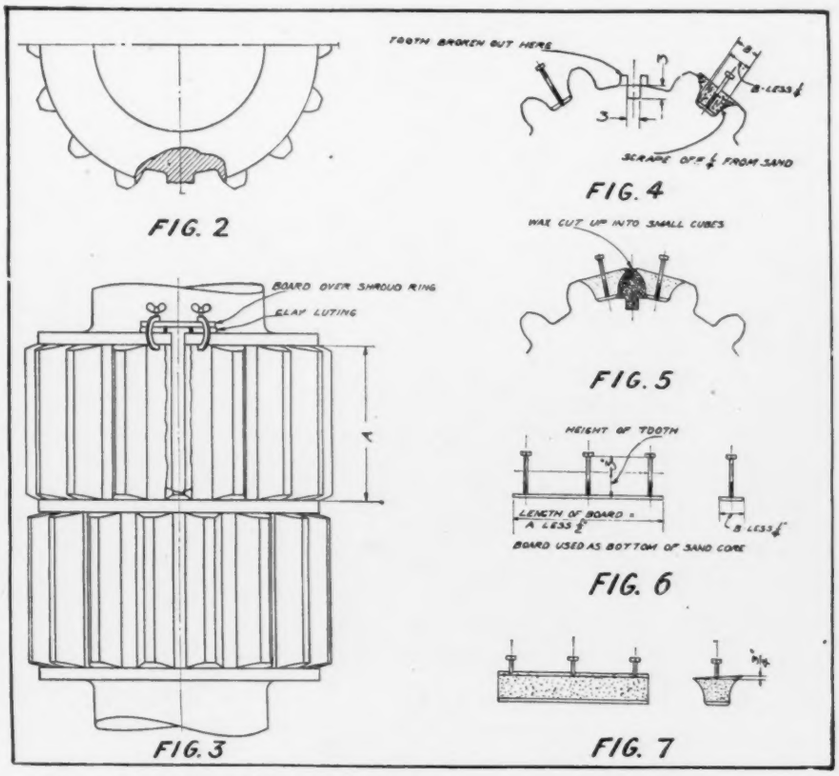


FIG. 2—SECTION THROUGH BROKEN TOOTH SHOWING USUAL LINE OF FRACTURE. FIG. 3—METHOD OF CUTTING SHROUD AND ATTACHING BOARD AND CLAY LUTING FOR WELDING SHROUD. FIG. 4—SAND CORE RAMMED TO FORM MOLD FOR ONE-HALF OF TOOTH. FIG. 5—BOTH CORES IN POSITION AND FILLED WITH WAX. FIG. 6—DESIGN FOR BOARD TO SUPPORT BOTTOM OF SAND CORES. FIG. 7—SECTION AND ELEVATION OF SAND CORES USED AS ONE-HALF OF WAX PATTERN MOLD

If wheels are mounted with lead bushings protruding, pressure on the lead, when the wheel is tightened in place, is sufficient to break wheels or to put such additional strain on them that they will break later while in use.

Another point to be taken into consideration is that the bushing arbor should be so located that when the lead is poured around it, a bushing of approximately uniform thickness will result. There are cases on record where in re-bushing the wheel to get a smaller arbor hole, the bushing arbor was not centrally located, consequently when the wheel was mounted it ran badly out of true.

Standardization of Core Prints

By W. W. Carlson

In the construction of machinery and equipment, standardization has reached a high state of development and the interchangeability of various parts is a big factor in facilitating the sale of the tool. In the machine shop the standardization of various parts has been carried much farther than in any other department of the manufacturing plant, the foundry usually being placed at the end of the standardization plan while a nearby friend is the patternmaking department.

After a fruitless effort to find some kind of a standard for core prints for patterns, the writer, with the aid of the foundryman and pattermake., has adopted a scheme shown in the accompanying illustration, which is worthy of consideration. This is used as an early exercise in training students in patternmaking in the shops of the Kansas State Agricultural College, Manhattan, Kas.

If a supply of these core prints is kept on hand ready for use, they will prove a time saver in many cases and they will effect economies in labor cost, particularly in view of the fact that they can be produced by a cheaper grade of help than the journeyman patternmaker. As noted in the accompanying illustration of the vertical print, the upper and lower tapers are different. The lower print is tapered just enougt to let in the core and to permit it to stand steadily in place. The upper print has a greater taper to facilitate the proper entering of the core but not enough to cause trouble from the metal running over the end of the core and closing the vent in case the core is a little shorter than it should be.

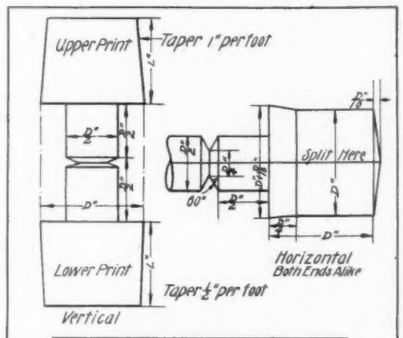
The prints for horizontal cores are made with the length proportional to the diameter and are left conical at the end next to the pattern to reduce the danger of crushing the sand as the core is put into place.

It is appreciated, of course, that these proportions will not apply in all cases, but it is believed that they will prove helpful to those who take pride in doing their work in a systematic way.

A Casting for Ammonia Fittings

By W. J. Keep

Question:—I am sending you a small piece of an elbow fitting, and I would like to know what brand of pig iron you would recommend for making such castings. The freight being the same for No. 1, No. 2 or No. 3, it would be better, perhaps, to have No. 1 iron and use some selected scrap. The intention is to produce such castings as valves, elbows, tees, etc., for ammonia fittings, such as are used in ice machinery. You will note the density, softness and color of the metal. It is very satisfactory and will not leak when under pressure. What is in the metal that makes it have such a dark color? I enclose an analysis of this fitting.



D	L	D	L
3/8"	5/8"	1 7/8"	1 1/2
1/2"	3/4"	2"	1 1/2
5/8"	7/8"	2 1/8"	1 1/2
3/4"	7/8"	2 1/4"	1 1/2
7/8"	7/8"	2 3/8"	1 1/2
1"	7/8"	2 1/2"	1 1/2
1 1/8"	1"	2 5/8"	1 1/2
1 1/4"	1"	2 3/4"	1 1/2
1 3/8"	1 1/8"	2 7/8"	1 1/2
1 1/2"	1 1/4"	3"	1 1/2"
1 5/8"	1 1/4"	3 1/8"	1 1/2"
1 3/4"	1 1/4"	3 1/4"	1 1/2"

STANDARD CORE PRINTS

Answer:—The following are the analyses recommended by the American Foundrymen's Association:

Ammonia cylinders: Silicon, 1.00 to 1.75 per cent; sulphur, under 0.09 per cent; phosphorus, 0.30 to 0.50 per cent; manganese, 0.70 to 0.90 per cent and total carbon, 3.00 to 3.50 per cent.

Acid-resisting castings: Silicon, 1.00 to 2.00 per cent; sulphur, under 0.05 per cent; phosphorus, under 0.40 per cent; manganese, 1.00 to 1.50 per cent, and total carbon, 3.00 to 3.50 per cent.

Your casting has the following analysis: Silicon, 1.55 per cent; sulphur, 0.039 per cent; phosphorus, 0.16 per cent, and manganese, 0.50 per cent.

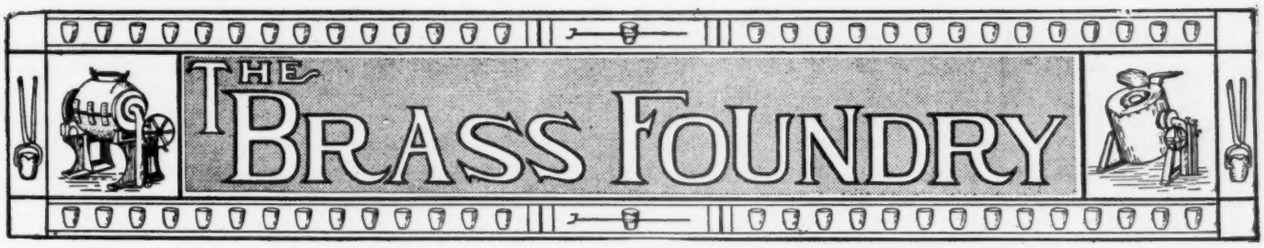
If you would melt with coke it would not be possible to get as low sulphur, phosphorus and manganese as you give and I am inclined to doubt the authenticity of this analysis. But since you propose to melt with an electric furnace you may produce as good a casting, but you would be obliged to exercise great care in selecting your pig iron. The carbon gives the dark color to the casting. You would be obliged to use No. 3 pig to get the close grain and low silicon, but you will find it difficult to get the low sulphur and phosphorus. As you are on the Pacific coast and have cheap electric current, it will be very interesting to learn the results of your experiments.

Size of Cupola for a Stove Plate Foundry

By W. J. Keep

Question:—We operate a stove plate shop and we would like to know whether a 96-inch cupola lined to 78 inches would be an economical investment for our work. This question recently has been propounded and various opinions have been expressed, but we have been unable to obtain the right information thus far.

Answer:—A 96-inch cupola would be too large for economical operation. It would melt too fast for one spout and two spouts are not convenient. The melting capacity of this cupola, if one of such size is to be installed, naturally would be representative of the size of the shop and this, of course, would have to be extensive. Therefore, unless bull ladles were used or an overhead trolley system installed, the men would have to carry their iron too great a distance to their floors, and this would result in so much confusion in the gangway that it hardly would be safe for the men. Two charging doors would be required to distribute the metal uniformly and the bed would be too large for any but heats too great for a stove foundry. Also, if the heats were cut down the coke consumption per pound of iron produced would increase tremendously. A cupola with a 72 or 78-inch shell, lined to 54 or 60 inches, would serve your purpose admirably. This cupola might be lined smaller below the tuyeres and could be boshed out to 62 or 68 inches above the tuyeres. Melting 28 tons, this cupola will have a ratio of approximately 9 to 1. By installing two cupolas no more help would be required than is necessary in the operation of the large furnace that you have in mind, and if at any time it is necessary to reduce your heats, only one cupola would have to be operated and the employes on the charging platform could be reduced one-half.



Chemistry for the Brass Foundryman---I

By E P Later

THE current unpleasantness abroad has made its influence felt in practically all lines of business, but it is probably safe to say that none has been more profoundly affected than that which has to do with the non-ferrous alloys. The tremendous demands for ammunition and supplies of all kinds—the former alone accounts for several hundreds of tons of brass each day—have been a serious drain on our stocks of copper, zinc and some of the other metals, and as a result prices have advanced to almost unheard-of levels. The pure metals have been hard to obtain and even good scrap has been at a premium, some varieties having practically disappeared from the market. In consequence, everything that could be sold as old metal has been offered for sale; a good deal of this has needed careful handling and the uncertainty of its composition has caused trouble in various ways. The price of these metals is determined largely by the current price of copper, but aside from that, the successful mixing and working of these depends on accurate knowledge of their make-up, which can be obtained only by chemical analysis.

Most large concerns have a chemical laboratory and for those who do not have one there are many commercial laboratories where materials may be sent for analysis. Cases come up right along where a short examination of an alloy, say, with the estimation of one or two of the metals in it, would save any amount of time and trouble, which in the long run means money.

Simple Methods of Determination

Doubtless many firms refrain from putting in their own laboratory because of the supposed expense connected therewith, both the initial outlay and the operation and maintenance. It may be said, however, that it is possible to equip a small laboratory adequate for certain simple determinations, for a very reasonable sum and by using carefully selected methods anyone with a high school knowledge of chemistry, or even without it, can turn out results sufficiently accurate for most purposes at least. In this series of articles, therefore, simple methods for determining the various constituents of some of the more important non-ferrous alloys will be given and it is hoped that they will help to solve what is often a perplexing question.

Elementary Methods

It may not be out of place to note that no claim is made for originality in any of the methods, but every effort will be made to present only those which can be relied on to give close results. This series is intended for those who do not have a thorough knowledge of analytical procedure and the manipulation has been simplifield as much as possible, leaving out all unnecessary refinements, with the idea of striking as near a balance as may be between accuracy on the one hand and speed and simplicity on the other.

At the same time it must be borne in mind that successful work of any kind requires care and some attention to details, and this is perhaps especially true in chemistry. Unless volumetric solutions are accurately standardized, weighings carefully made and the apparatus kept clean, to say nothing of following directions closely, the results will be correspondingly less trustworthy, and inaccurate results are often worse than no results at all, for they are misleading.

Considering the laboratory and its equipment, a bright, clean and airy place should be selected, preferably not in the foundry proper, so as to avoid smoke and dust. It need not be so very large, but if possible there should be available gas, electricity, water and sewer connections. The water and gas should be piped to the desk, providing three outlets for the water, one tap and one jet, over the sink, and one connection for the still. Of the gas, one or two outlets will be required for bunsen burners on the desk, with one for the still and in the hood one for the hot plate and one bunsen burner.

A desk with drawers, shelves and so on can be purchased from any of the large supply houses, but a good carpenter can build one which will serve the purpose well enough. It is hardly worth while to attempt to give dimensions here, since the requirements will vary with the kind and amount of work to be done, but it should be large enough to hold enough apparatus for two or three determinations without being crowded; the sink should be in the middle or at one end. Two stout shelves for reagent bottles with two drawers, say, at each end and a cabinet built-in below them will make for convenience in working. The top of the desk should be hard wood, which will need blackening and oiling. This may be done by painting with a solution of 125 grams copper sulphate and 125 grams potassium chlorate dissolved in water and diluted to one liter, 1,000 cubic centimeters. When dry, apply a solution of 60 grams aniline hydrochloride and 90 c. c. strong hydrochloric acid, diluted to 500 c. c. Allow this to dry, then wash with hot water, after which the whole process should be repeated until a dark green color is produced. The surface should then be rubbed with raw linseed oil until a fine black is obtained.

Supply of Distilled Water

Distilled water is necessary for good work of any kind so a supply must be arranged for. It may be purchased, but it is better to put in a small still which may be run as required; it may be obtained from any chemical house. A large bottle of distilled water should be placed above the desk on a strong shelf; a large bent glass tube, one end dipping into the water and the other provided with a piece of rubber tubing and pinch cock, will make a satisfactory siphon from which water can be drawn as desired. It is also advisable to build a small

hood for removing fumes. Essentially, it is a sort of large box, lined with asbestos boards or sheet and with a flue leading to the open air. One or two glass sliding doors should be provided and arrangements made for gas outlets.

A very solid and firm support must be provided for the balance; it may take the form of a heavy table or a shelf fastened to the wall and suitably braced and supported. The main consideration is to secure as great freedom as possible from vibration.

Laboratory Apparatus

The apparatus required will be largely determined by the work to be done, but most of the pieces enumerated below will be necessary:

Balance: — This will be used for weighing samples and so on; one sufficiently accurate for present purposes may be obtained from any good supply house for less than $75.

Beakers:—Two or three nests of these will be needed.

Bottles:—Six or more glass-stoppered pint and about as many half pint reagent bottles will be required; in addition a dozen or more wide-mouthed bottles should be obtained for keeping samples, chemicals and the like. Six or eight-ounce is a convenient size. Several large bottles, those in which pure acids and ammonia are sold will serve nicely, will be needed for various solutions. Bottles for indicators may be purchased or easily made by sticking a fountain pen filler through a cork, allowing the indicator to be added drop by drop.

Burettes:—These are long glass tubes graduated in centimeters and provided with a glass stop cock, so that any desired quantity of liquid may be drawn off. Two or three of these should be secured as the necessity of cleaning and changing the solution every time a different titration is made will be eliminated, besides preventing the delay and inconvenience which would result if the only one available were accidentally broken. Several burette holders will be needed and may be purchased or made by any one with a little ingenuity.

Bunsen Burners:—Three or four of these will be needed.

Casseroles: — These are porcelain dishes with a handle attached. One large and one small one will be found very handy.

Crucibles:—These are made of porcelain or platinum and are used for burning off precipitates or for heating a substance to a high temperature. Those of 10 or 15 grams capacity are the most convenient size to get.

Platinum crucibles are made in all sizes and for many purposes are indispensable, but just now all platinum ware is very expensive and therefore, whether a crucible shall be purchased, will depend on how much money is available; if necessary it will be possible to get along without one.

Another form of crucible known as the Gooch, differing from the other kinds mainly in having the bottom perforated with many small holes, is very useful and several should be obtained. They can be used over and over again indefinitely, while the other form is generally useless after being used a few times.

Filtering Flask: — This is a thick-walled flask used in connection with a suction pump, for quickly filtering off precipitates. Use is made, for this purpose, of a special kind of paper known as filter paper. One package of so-called qualitative, say 9 cm., and one each of 9 cm. and 15 cm. quantitative paper should be purchased.

A filter stand, for holding the funnels during filtration, will be required.

Flasks:—These are thin-walled glass vessels. Six flasks of 300 c. c. and six of 500 c. c. capacity will be enough.

Funnels: — Three or four of these ranging from 2½ to 4 inches in diameter will be needed.

Gauze, iron wire, with asbestos center, used when heating flasks or beakers over a direct flame should be obtained. Three or four pieces will be enough.

Pipettes:—These are glass tubes with the middle portion blown into a bulb and used for accurately measuring-out certain quantities of liquid; a ring around the stem indicates the point where it contains the desired quantity. Pipettes are of various capacities and it would be advisable to obtain two of each of these sizes: Five c c., 10 c. c., 25 c. c.

Stove, Gas:—A flat, two-burner stove should be placed in the hood.

Suction Pump: — This is a device which is connected to a faucet and creates a suction when water is forced through it; it is used with the Gooch crucible and to promote quick filtering.

Generator

Sulphuretted Hydrogen Generator:—Certain of the metals can be separated from each other by passing this gas through the solution containing them; it is formed by the action of some acid, hydrochloric is generally used, on iron sulphide. What is known as the Kipp generator affords a very convenient means of providing a supply for instant use and may be purchased at any supply house. A satisfactory generator may be made, however, by taking a large flask or bottle provided with a rubber stopper and passing through the latter a thistle tube, a sort of long-stemmed funnel, with the lower end reaching nearly to the bottom, and a short piece of glass tubing bent at right angles. This is connected to another right-angled tube passing through the stopper of a smaller bottle half filled with water, and reaching nearly to the bottom of the bottle. Another short, right-angled piece of tube passing through the stopper is connected by a short length of rubber tubing to a piece of glass tube drawn down to a small bore in a flame.

Small lumps of ferrous sulphide are placed in the large bottle and a small quantity of dilute hydrochloric acid poured through the thistle tube. The gas evolved is forced through the wash bottle and issues from the end of the capillary tube, as it is called, by immersing the latter in a solution; the gas can be made to bubble through it and thus saturate it.

Volumetric Flasks:—These are glass flasks of various sizes, accurately graduated to contain a certain quantity of liquid. One of each of the following capacities should be added: Fifty c. c., 100 c. c., 250 c. c. and 1,000 c. c.

Washing Precipitates

Wash Bottle:—This is very useful in washing precipitates and so on, and may be made by bending a glass tube 6 or 7 inches long to an angle of about 600 degrees, about 4 inches from one end, the other being then passed through a rubber stopper until it protrudes an inch or so. Another tube, one foot in length should be bent to an angle of 30 degrees, 4 inches from one end, the other passed through the stopper until it nearly reaches the bottom of the flask. A capillary tube is made, as before, by drawing a short piece of tubing out to small bore in a flame, then cutting it in two and smoothing the rough edge and finally connecting it to the end of the long tube by a piece of soft rubber tubing. After partially filling the flask with water and forcing the stopper into place a fine stream of water will be thrown from the capillary tube by blowing gently through the other tube.

In addition to the foregoing, a number of small articles will be required for one purpose or another such as corks and rubber stoppers, a few three-cornered files, test tubes and holder, a few feet of glass and rubber tubing, wire or clay triangles for holding crucibles during ignition, crucible tongs for handling hot crucibles and the like, watch glasses, a dessicator containing calcium chloride for keeping crucibles and precipitates clean and dry, and so on.

Before going on with the discussion of the different methods by which the various metals are estimated, however, it may be of help to consider some of the problems involved and the mechanism of the processes employed in solving them. For the present purpose analytical

chemistry may be divided into two classes, qualitative and quantitative, the latter being further distingiushed as volumetric and gravimetric, which will be taken up later.

In qualitative analysis we are concerned with the question of resolving an alloy, or other substance, into its constituents, which may then be identified separately. In other words, the attempt is made to take the substance apart, as it were, and determine the various elements entering into it, without necessarily estimating the amount of each present. As might be supposed, this is done by taking advantage of certain properties or characteristics peculiar to each metal which serve to distinguish it from the other metals. This general subject will be dealt with at greater length in the succeeding article.

As the name implies, the aim of quantitative analysis is to find out the actual amount of one or more of the elements present, paying only such attention to the other elements as may be required in those cases where the presence of one interferes with the estimation of the other.

Volumetric Work

In volumetric work use is made of what are known as standard solutions, which means that they contain a certain and known amount of reactive substance per unit volume. Chemical reactions in the main take place in accordance with definite laws and in certain mathematical ratios between the substances which enter into the action, so it is easily seen that if we know how much active material a certain solution contains and how much of it is needed to combine with a known quantity of another solution, it is a simple matter to calculate exactly the amount of active material in the latter. This is the principle on which all of these methods are based.

For the sake of uniformity largely and to make the calculation simpler, volumetric solutions are usually prepared in certain strengths which are based on the molecular weight of the salt employed. This may be made clearer by explaining that a salt is made up of two or more elements, using this word in its chemical sense, each of which has its own specific or atomic weight. The specific or molecular weight of a salt, then, is the sum of the atomic weights of the elements composing it.

Care must be taken not to confuse these terms with measures of quantity or mass, such as ounces, grams or pounds. An element is composed of molecules which in turn are composed of two or more atoms; the hydrogen atom is the lightest known and has been arbitrarily called 1; formerly the atomic weight of the other elements was compared with it. In this way oxygen has been said to have an atomic weight of 16, because its atom is very nearly 16 times heavier than that of oxygen; as a matter of interest, the atomic weight of oxygen is now used as the standard in calculating those of the other elements.

Normal Solution

Now as to the application of all of this, sodium chloride, common salt, is composed of one atom each of sodium and chlorine, consequently its molecular weight is the sum of the weights of these, 58.5. If 58.5 grams of this, a little over two ounces, are dissolved in water and the solution diluted to one liter 1,000 c. c., a normal solution is produced. In a chemical sense a normal solution may be considered to be one which contains the molecular weight of the salt in grams divided by what is known as the hydrogen equivalent, dissolved in water and diluted to one liter. The hydrogen equivalent may be defined as the number of active or replaceable hydrogen atoms in the compound. For example, nitric acid has a molecular weight of about 63; with only one replaceable hydrogen atom, therefore, a hydrogen equivalent of one, a normal solution of nitric acid would be made by diluting 63.02 grams of it to exactly 1,000 c. c. Sulphuric acid has two replaceable hydrogen atoms, and a molecular weight of approximately 98, so a normal solution would be made by diluting one-half of the molecular weight in grams, or 49.05 grams, to 1,000 c. c.

It is often desirable to have solutions which are much weaker than normal, so by taking ½, 1/10, 1/50 and so on of the normal weight, solutions of ½, 1/10, 1/50 normal strength may be made; these are usually designated $\frac{N}{2}, \frac{N}{10}, \frac{N}{50}$.

For further information the operator should refer to some of the standard books on quantitative analysis.

It is hardly necessary to add to what has been given, that a certain volume of one standard solution is exactly equal to the same volume of any other solution of the same normality, provided, of course, that both have been properly prepared; that means that a tenth normal solution of any acid will just neutralize its own volume of any tenth normal alkali; 15 c. c. of twentieth normal hydrochloric acid will combine exactly with all of the silver in 15 c. c. of a twentieth normal solution of silver nitrate.

In most volumetric work it is necessary to make use of what are known as indicators, substances which, by their behavior serve to show the presence or absence in a solution of some of the reacting compounds. Certain organic bodies, for example, show by a change or absence of color the presence of acids or alkalis; litmus is blue with alkalis, red with acids, phenol-phthalein is pink with the former and colorless with the latter. Starch solution, uranium acetate, potassium chromate and ferric alum are other examples of a large number of substances which are employed in this way.

In gravimetric analysis the intention is to convert the metal or element desired into some form insoluble in water or other medium, then it is an easy matter to filter it off, get rid of the filter paper by burning and weigh the residue, which will give data enabling the results to be calculated. Chemical methods may be employed to do this or the electric current utilized to deposit the metal on a suitable cathode where it can be weighed in metallic form. In accuracy, simplicity and ease of manipulation these electrolytic methods have much to recommend them when certain metals are to be estimated, and it will pay to obtain the necessary apparatus for doing this sort of work.

There are several forms of cathode, but perhaps the most suitable is a fine gauze or screen, cylindrical in shape, with a stiff wire several inches in length welded on one side. Different metals have been used for making these, but inasmuch as one of the main requirements is that the gauze shall not be attacked by any of the solutions employed, platinum is generally used and is to be recommended. The initial cost is higher, of course, but with care these cathodes are practically indestructible and may be used indefinitely.

The anode is a heavy platinum wire usually twisted into the form of a spiral.

Electric Current

A source of direct current of at least three to four volts pressure must be provided and several Grenet cells, or storage or other cells which will give good current for several hours at a time may be used.

Whatever the source of current, it will be advisable to place both a voltmeter an ammeter in the circuit; inexpensive forms of these instruments, either mounted in a single case or separately may be obtained from supply houses. If batteries are used the strength of the current may be regulated by adding or taking these out of the circuit, or, in any case, by a simple rheostat consisting essentially of a number of coils of resistance wire so connected that any or all of them may be thrown into circuit.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Flux for Yellow Brass Scrap

What is the best flux to use in melting yellow brass scrap to secure sound castings? We would like to know if there is any better method of fluxing red brass other than using 1 per cent of phosphor-copper containing 5 per cent phosphorus.

No flux should be necessary in melting yellow brass, since the zinc should take care of any oxidation. However, if the castings are porous, the difficulty can be corrected by the use of manganese-copper containing 30 per cent of manganese. Use 0.25 per cent of manganese-copper, since as small an amount of manganese as possible should be introduced, but if it is found to be insufficient for deoxidizing, it may be increased to 0.5 per cent. Manganese is a better deoxidizer of yellow brass than phosphorus, but it cannot be used with the same freedom. Iron also is an excellent deoxidizer for yellow brass, but it should be employed in the form of yellow prussiate of potash, 1 per cent being sufficient. Phosphor-copper usually contains 15 per cent of phosphorus and the addition of 1 per cent should be sufficient to give the desired results.

Melting High-Zinc Brass Turnings

By what method can very fine, high zinc brass turnings be melted with a minimum of loss and we would like to know what the loss would be by the method which you recommend. The composition of this metal is 60 per cent copper and 40 per cent zinc.

Brass turnings can be melted with a minimum loss if a bath of the same metal as that represented by the turnings is first allowed to gather in the crucible. To accomplish this, melt several ingots from some previous heat. The bath should be fluid and into this should be charged as many turnings as can be taken up and the mushy metal should be covered with fine charcoal. The contents of the pot then again should be permitted to become fluid, after which the operation should be repeated until the crucible is full. The operation at first proceeds slowly, but as the metal gathers, more turnings can be charged at a time and then the operation is carried on much more rapidly. A small amount of salt should be added from time to time to recover the metal that might otherwise be carried into the dross. It is difficult to name an average loss from this operation owing to the fact that if the work is done properly the losses will be low, but if the melting is improperly carried on, the losses will reach a maximum and will depend upon the amount of zinc volatilized. Melting metal is like boiling water. The longer it is heated and vaporized, the more metal will be lost. Water can be boiled away or it can be brought to the boiling point with a minimum loss and the same applies to metals. Consequently, the minimum of loss requires the maximum of attention.

Porous Brass Bearings

We have experienced considerable trouble in making small brass bearings weighing two or three pounds each. When the bearing is bored it is found to contain blow-holes, some of them of considerable size. The metal is melted in natural draft furnaces and the surface is covered with charcoal. The alloy used consists of copper, 85 per cent; tin, 5 per cent; lead, 5 per cent and zinc, 5 per cent.

In nine cases out of ten this difficulty is caused by the oxidation of the metal while it is being melted, and, therefore, it can be so considered in this instance. The mere fact that charcoal is used as a cover does not eliminate the possibility of burning the metal. We suggest that when the crucible is charged a crucible ring be placed on top of the pot so that all of the copper charged can be placed in the crucible at one time. On top of the copper, place sufficient fine charcoal to afford a cover at least 2 inches thick and also add a small handful of salt. Melt the copper quickly, stir in the mixture, pull the pot, skim the metal and pour. If the castings still continue porous, the difficulty cannot be charged to the melting process. In the event of this occurrence, obtain a coarser grade of sand and if the bearings are cast down, they should be vented. The gates should be changed to the end of the casting and it will be necessary to make this of heavy section to properly feed such a heavy piece. These molding changes, coupled with careful melting, should remedy this difficulty.

Overcoming Porosity in Red Brass Castings

We are experiencing considerable difficulty in making brass castings, owing to the pitting of the surface. Our mixture consists of the following: Copper, 44 pounds; tin, 1 pound; zinc, 2 pounds and lead, 3 pounds. Selected scrap is used consisting principally of globe valves and all of the scrap is picked over carefully to detect iron and other impurities. The mixture mentioned is used in the proportion of two-thirds new metal and one-third scrap. The metal is melted in a coke-fired furnace. Lead for this mixture is purchased from a scrap dealer in 4-pound ingots and we are inclined to believe that this metal is causing the trouble. Probably it contains antimony, although our castings indicate that the metal is burned. We melt a bath of about 25 pounds of scrap, to which is added a small amount of salt, then we introduce the copper and the entire bath is covered with granulated charcoal. The metal is melted as quickly as possible and is poured when ready, not being permitted to soak in the furnace. The trouble we are experiencing recurs at intervals of several months, although in the meantime we seem to experience no difficulty whatever.

We are inclined to believe that your difficulty lies in the molding of the castings and not in the melting of the metal, since the porosity is confined entirely to the cope surface of the casting and the holes are clean and are not oxidized, indicating that they were caused either by hydrogen or steam. Deoxidizers should not be required in red brass because if they are not used skilfully the remedy is worse than the cure, since they disturb the harmonious relations which ordinarily exist between the constituents. The molder probably is ramming the cope too hard or a new man has taken up the work. Also, it is possible that the metal is being poured hotter than ordinarily, which is liable to be the case if a number of castings have misrun recently as a result of careless, cold pouring. It is evident that the difficulty is attributable to the fact that the metal will not lie quietly against the surface of the cope. By exercising proper care in molding and also in melting the metal, you should be able to eliminate further trouble.

Fig. 1—Small electric truck loaded with 3,000 pounds of phosphor bronze turnings which will be recovered and recast

Fig. 2—150,000 pounds of bronze journal bearings ready to be recast. Ordinarily 75 per cent of the metal used in the manufacture of bearings is scrap

Growing Value of the Non-Ferrous Scrap Pile

THE modern brass foundry has always been considered a fertile field for the development of systematized reclamation of waste materials, but it has required a phenomenal rise in the price of non-ferrous scrap to bring home to many manufacturers the real importance of saving every particle of metal that can be recovered economically. An example of the extent to which scrap may be utilized or turned to good account is furnished by the practice in vogue at the brass foundry of the Pennsylvania railroad at Altoona, Pa.

This foundry makes a large percentage of the brass castings used on locomotives and cars on the Pennsylvania lines east of Pittsburgh. The output, which amounts to about 35 tons every 24 hours, consists of journal bearings, metallic piston rod and valve stem packing, valves, cocks, driving box shoes and wedges, and miscellaneous locomotive and car castings of brass and aluminum.

The organization of the maintenance of equipment department of the railroad is such that the scrap metals which accumulate at all points where cars and locomotives are repaired, may be collected at the principal shops on the various divisions, and from there shipped to the foundries of the company at Altoona and Renovo, Pa. At these points, and especially at Altoona, means have been developed to reclaim a large amount of the scrap materials received from the outlying shops. A small percentage has to be sold because the company has no way of economically recovering the metal.

Of first importance in the value of scrap is the class of material known as journal bearings. A few years ago these bearings constituted 50 per cent of the output of the foundry, but at the present time they amount to only 30 or 40 per cent of the total. The bearings are made of bronze and are lined with a soft metal. The linings are melted out of the bronze bodies and cast into ingots which are remelted to re-fill bearings in which the linings have worn below the standard limit of wear. The system for recovering this material is so complete that only 25 per cent of new metal is used in the ordinary manufacture of journal bearings. Fig. 2 shows a bin containing 150,000 pounds of old bronze bearings, waiting to be recast.

Sorting the Scrap

Another source of recovered brass is the discarded and broken valves, spindles, cut-out cocks, nipples, brasses, etc., which accumulate in engine houses and machine shops. Material of this kind is shipped to the foundries, where an inspector goes over it to separate the iron and other foreign metals. Many of the more complex articles, apparently brass from the appearance of the exterior, have iron or steel sleeves o spindles inside. The inspector carries a small portable electric magnet, which instantly detects the presence of the undesirable metal, and the article is set aside to be broken up so that the brass may be separated from the iron or steel. The clean brass obtained in this manner is melted and goes back into the manufacture of castings.

Phosphorus and plastic bronze turnings from the various machine shops furnish a considerable amount of scrap. Fig. 1 shows 3,000 pounds of phosphor bronze scrap reclaimed at the Altoona machine shop. In most cases material of this kind is comparatively free from dirt, as the machine shop workmen are instructed to use different receptacles under their machines to catch the chips from each kind of metal. Unless the bronze is badly mixed with non-metallic materials, it is fed to a magnetic separator, which picks out the iron and steel particles. Analysis of the metal as it comes from this machine shows that the bronze is extremely free from foreign substances. It is melted and used again in the making of bronze castings. Over 75,000 pounds of turnings of this kind are recovered from the magnetic separator each month at Altoona.

The manufacture of soft metal for piston and valves stem packing is an important part of the work of the Altoona foundry, since the packing for practically every Pennsylvania locomotive east of Pittsburgh is made there. On account of the necessity of maintaining a constant quality of metal, samples of the ingots are carefully analyzed before the metal is poured into the form of packing. This procedure simplifies the use of scrap metal considerably, for it enables the testing laboratory to prepare a

formula to bring the resultant metal up to standard.

The packing metal, discarded when shopmen renew the packing, is sent to the storehouse, where it accumulates and is later sent to the foundry. Here it is melted and cast in pigs. About 4,000 pounds are melted at one heat. The pigs of each heat are carefully labeled, and samples are sent to the laboratory. A record of the analysis is kept, and a formula showing the ingredients which must be added to the scrap to bring the resultant metal up to the specifications of standard packing metal is prepared. The pigs are melted again and new materials added according to the formula. If the resultaut mixture is satisfactory, as shown by a final analysis, the metal is ready to be cast into packing. The average quality and quantity of the metal reclaimed is such that the formulas provide for about 50 per cent of scrap and a like amount of new metal.

Disposal of Sweepings

The sweepings from the foundry floor contribute about 7,000 pounds of clean brass each month. The material is wheeled from the floor of the foundry to a ball mill, which crushes the material and washes the mud from the metal. After it has been reduced to a comparatively clean mixture of various metals, it is fed through the magnetic separator. The analyses of the brass as it leaves this machine show that not only the iron and other magnetically affected metals, but also the antimony has been removed. Fig. 4 shows a bin of foundry sweepings which will undergo the cleansing and reclamation process.

Crucibles from the foundry are usually sold to smelters. Very little attempt has been made to reclaim the brass from the crucible at Altoona. The broken pots, shown in Fig. 3, are held until 10 or 15 tons have accumulated and then they are sold. From $5 to $6 per ton is paid for this kind of scrap.

Copper Wire

The recovery of non-ferrous metals, however, is not confined to the recovery of cast brass parts. Copper wire is utilized by burning the insulation, cleaning the ash, cutting the wire into convenient bundles, melting it, and casting in small pigs. Car seals are heated to recover the lead. Batteries are saved and the lead, zinc and the mud recovered. Another source of lead is the obsolete and condemned driving wheel centers from locomotives. Large passenger locomotive wheels contain about 500 pounds of lead to counterbalance the throw of the rods and crank pins. This metal is recovered by heating the center and pouring the molten lead into pigs of convenient size. The wheels are stripped of their lead content at a cost of about $0.40 each.

The price of scrap and the cost of reclaiming it are the two factors governing the extent to which recovery of metals may be carried with economy. Until the recent high prices of non-ferrous metals and alloys, it was questionable whether the extensive efforts to reclaim brass from sweepings, and from other small sources was a paying proposition in many shops. In too many cases the cost of labor more than offset the value of the materials saved. Existing conditions in the old metal market have changed this, and at the present time, perhaps as never before, there is good reason for waging the war against the waste of scrap material with unusual thoroughness.

FIG. 3—CRUCIBLES FROM THE BRASS FOUNDRY TO BE SOLD TO SMELTERS WHO RECOVER THE BRASS

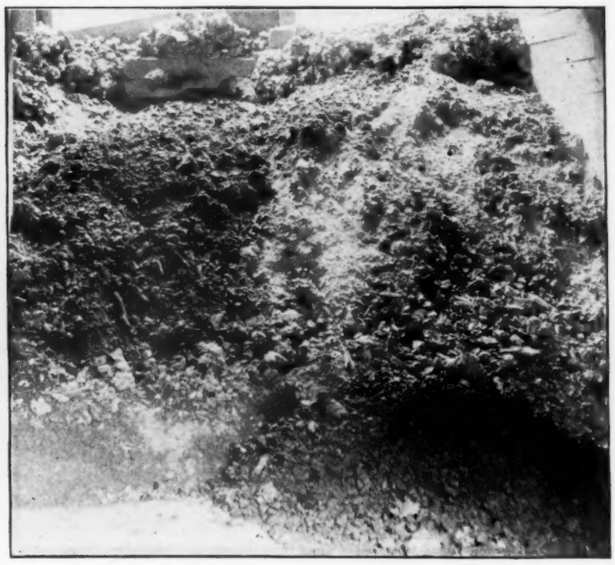


FIG. 4—A BIN OF FOUNDRY SWEEPINGS. THIS MATERIAL WILL BE WASHED AND SCREENED AND THE BRASS RECLAIMED

Furnace Specialists Incorporate

The Quigley Furnace Specialties Co., 26 Cortland street, New York City, has been organized for the purpose of engaging in the design and construction of all kinds of heating and annealing furnaces. The furnace specialties department will manufacture and deal in a line of furnace materials, equipment and appliances for the improvement of furnace construction, operation and methods, including high temperature furnace cements, insulating brick, automatic fuel oil valves, oil, gas and powdered coal burners and appliances, temperature and draft controling and recording systems, gas analyzing instruments, etc. The engineering and contracting department of this company will analyze and make comparative statements of operating costs of powdered coal, hand or stoker-fired coal, gas and fuel oil and will make recommendations as to the most economical fuel and its applications. Complete plans, specifications, estimates and supervision for the entire installation and application of any fuel, including furnace alterations or new construction, will be furnished. W. S. Quigley, who has a wide experience in the design and construction of heat-treating furnaces, is president, H. A. Kimber is vice president and J. H. McFadden secretary.

Standard for Cast, Zinc-Bronze Test Specimens

Results of an Investigation Conducted by the Bureau of Standards, With Suggested Specifications for Brass Foundrymen

A BULLETIN, entitled "Standard Test Specimens of Zinc-Bronze", has been issued by the United States Bureau of Standards, which covers an investigation of test bars made of a mixture consisting of copper, 88 per cent; tin, 10 per cent and zinc, 2 per cent. The bulletin is divided into two parts, the first comprehensively dealing with the preparation of specifications by C. P. Karr, associate physicist and the second covers the microstructure of test specimens made from this mixture, by Henry S. Rawdon, assistant physicist. The work of preparing an alloy of zinc, tin and copper for the purpose of obtaining a standard form and dimension of test bar was undertaken by the Bureau of Statistics at the request of the American Institute of Metals and preliminary accounts of this work were published in the *Transactions* of this society in 1913 and 1914.

Test Piece and Casting

Mr. Karr points out that the test piece should correspond to the type of casting so as to be representative of the principal physical properties of the latter. Where it is desirable to obtain a knowledge of the physical properties of a casting made in sand, the test bar should be cast in sand approximately at the same time and from the same heat. As a result of the experiments made at the Bureau of Standards, it is possible to secure specimens cast to size in sand and poured within a range of temperatures from 1,120 to 1,270 degrees Cent., which will have a tensile strength of 37,000 pounds per square inch, an elongation of 15 per cent in 2 inches and a reduction of area of 14 per cent. Under conditions maintaining in regular foundry practice, using similar materials, such a test bar might be expected to have a tensile strength of 33,000 pounds per square inch, an elongation of 14 per cent in 2 inches and a reduction of area of 13 per cent. However, if a bar of similar character be heat-treated to 600 degrees Cent. in a furnace for 30 minutes and quenched or allowed to cool in the furnace to normal temperature, it may be expected to show a tensile strength of 36,000 pounds per square inch, an elongation of 25 per cent in 2 inches and a reduction of area of 24 per cent.

The results of this investigation are summarized as follows:

1—The best type of test bar where the metal is to be cast into sand is the cast-to-size shape. If the metal be poured within the range 1,120 to 1,270 degrees Cent. (2.048 and 2,318 degrees Fahr.), greater uniformity of tensile strength and ductility may be secured.

2—It was anticipated at the beginning of these investigations that some one temperature would be found at which the best and most uniform results as to the two important physical properties—tensile strength and ductility—would be obtained, but the series of tests showed that instead of one such temperature there was a zone of temperatures, 1,120 to 1,270 degrees Cent. (2.048 to 2,318 degrees Fahr.), at which good results might be expected anywhere within that favorable zone of pouring temperatures.

3—The kind of mold to be recommended is dry-sand, which should be poured either flat or vertical. The first method is more economical of time and labor, but has, however, no superiority over the vertical pouring in the matter of technical results.

4—The results of the chill and best sand-cast test bar are of almost equal value if the chill bar be annealed at temperatures ranging from 500 to 700 degrees Cent. (932 to 1,292 degrees Fahr.), but otherwise the former is inferior to the sand cast-to-size shape as a representative test bar.

The advantages of the chill bar are that there are no molding requirements and that it can be poured by unskilled labor. Its disadvantages are that it is expensive to machine into shape and size required for testing, and it gives results both as to tensile strength and ductility that are misleading.

The advantages of the cast-to-size shape are that it is easy to mold and inexpensive to machine into the shape and size required for testing. From the results obtained it is believed to be the form which should be adopted as standard for general foundry practice.

5—Heat treatment is productive of increased ductility, and has a marked effect on the deformation produced by continuously increasing loads on specimens annealed in the temperature zone of 600 to 700 degrees Cent. (1,112 to 1,292 degrees Fahr.), which is in accord with the results of other observers.

6—As an alternative for the sand-cast specimen, if one prefers to work with a chill-cast specimen, as is the case in some foundries, the results show for the few observations taken that when annealed between a temperature range of 500 to 700 degrees Cent. a normalized chill bar is secured which is comparable to the sand cast-to-size shape. The specimens annealed and quenched offer no appreciable superiority to the specimens annealed and cooled slowly.

7—The average density of sand-cast specimens is about 8.58 and of chill cast about 8.6.

8—The elastic limit of this zinc bronze varies from 15,000 to 17,000 pounds per square inch.

9—The cooling curves show that the melting point of the alloy is about 980 degrees Cent. (1,796 degrees Fahr.) and that there is a pronounced transition point at 780 degrees Cent. (1,436 degrees Fahr.) and another feeble one at 530 degrees Cent. (986 degrees Fahr.)

10—In the accompanying table is recorded a summary of all the results obtained for physical properties arranged in terms of the type of casting.

General Averages of all the Observations Taken

Number of bars.	Shape	Tensile Strength Pounds per square inch	Elongation in 2 inches per cent.	Reduction of area per cent.
217	Cast to size	37,869	15.5	14.7
161	Cylindrical	32,832	14.9	13.9
95	Barrel	32,029	14.2	13.8
88	Chill cast	36,512	6.3	6.9
21	Sand cast, an'ld	38,190	27.0	26.0
16	Sand cast, q'nch'd	39,810	26.9	24.2
5	Chill cast, an'ld	31,160	17.0	16.7

In all of the above it is to be borne in mind that only pure copper, tin and zinc have been used, and the results obtained are characteristic of variations in foundry practice on virgin metal only once or twice melted except as noted in the text. The presence of scrap containing small amounts of lead, manganese, iron and other ingredients which might influence the results of the tests with a standard bar are thus eliminated.

As a result of these investigations the following suggested specifications for the preparation of standard zinc bronze (copper, 88 per cent; tin, 10 per cent and zinc, 2 per cent) have been prepared:

Weigh out the required quantities of electrolytic copper, Straits tin and Horsehead zinc. Cover the bottom of the crucible with pieces of charcoal about the size of a hickory nut. Put in all the copper the crucible will hold, and cover the surface with small pieces of charcoal (no dust). Should the crucible not have the capacity to contain all of the copper charge, heat the charge contained until one or two of the pieces of copper are melted, crowd the remainder

down into the molten mass, and add the remaining copper, bring the whole charge into a molten state, then add the tin, stirring the whole thoroughly with a graphite rod stirrer, and after previously heating the zinc, add the amount of zinc weighed out and stir thoroughly. Keep the pot covered with a graphite cover during the melting period. After adding the zinc allow the whole charge to come to a good melting heat, denoted by the play of zinc flames over the surface of the edge of the surface adjoining the crucible. Remove the pot from the fire and take the pouring temperature with a thermocouple. Pour the metal at any temperature between 1,120 and 1,270 degrees Cent. (2,048 and 2,318 degrees Fahr.), but note the temperature at which the bars are poured. Use P-Pt Ir or P-Pt Rh (10 per cent) thermocouple protected by a fused silica tube or an equivalent pyrometric method of determining the pouring temperature. When using platinum-rhodium couples add five-tenths of the temperature recorded at the cold junction to temperature reading of millivoltmeter for the corrected pouring temperature, or 0.75 when using a platinum-iridium couple.

Molding

Use any good molding sand equal to Albany No. 2. If green sand be used, the moisture content should not exceed 12 per cent. If dry sand be used, face the mold with a layer of sand equal in fineness to No. 00 Crescent sand, tempered with molasses water. When the mold is finished spray the molds and runners and pouring gate with molasses water, and dry each flask before the drying oven until the deepest pattern or feeding gate is completely dry. Allow the mold to cool to room temperature before being poured. Pick the vent holes with a fine needle in every one of the bulb reservoir feeders.

Put not less than three patterns of cast-to-size shape in each flask.

Skim the pot carefully before pouring and hold back dross and scoriae with the skimmer as much as possible before pouring. Pour steadily with a stream that will just about half fill the runner, and not large enough to choke the bore of the runner, so as to allow the bulk of the gases carried down by the pouring stream to escape upward through the space left in the runner and the pouring head. With every heat pour a wedge-shaped chill bar about 13 inches long by 1½ inches deep by 1½ inches wide on top. Always pour the chill bar nearly flat and from the same end. Each chill will make three test bars. Always begin the numbering of the chill bars from the pouring end.

The size of the cast specimen in the rough should be 4½ inches long ⅝ inch diameter at center, and ⅜ inch diameter at threaded ends.

The size of the finished specimen should be, length over all, 4½ inches; length of center section, 2 inches between gage points; size of threaded ends, ¾ inch diameter by 1 inch long; length of each fillet ¼ inch and diameter of center section, 0.505 inch.

The foregoing specification with those of the United States navy are discussed as follows:

The navy specifications call for a tensile strength of 30,000 pounds per square inch and an elongation of 15 per cent. A comparison of the tests of the zinc-bronze bars with these requirements are shown in the accompanying table.

How Zinc-Bronze Bars Meet Navy Specifications

	Percentage of bars meeting navy requirements	Percentage of the remainder coming within 10 per cent of same	Percentage meeting only requirements of tensile strength
Cast in sand:			
Cast-to-size shape	53.0	27.0	89.8
Cylindrical shape	52.8	27.7	73.3
Barrel shape	42.1	10.0	66.0
Cast-to-size shape an'led	100.0	....	....
Cast-to-size shape q'nch'd	100.0	....	....
Cast in chill mold:			
Chill bar	4.5	1.0	87.5
Chill bar annealed.....	100.0	....	....

If one considers the tensile strength alone, it will be found that all of the test shapes and methods might be considered satisfactory, but the requirements for elongation are so rigid that only when the bar or the casting to which it refers is submitted to heat treatment is one able to meet these requirements; also this treatment restores the metal to its natural state and true condition and thus develop fully the physical properties of which it is capable.

If we study the effect of heat-treating test bars at the various temperatures of 500, 600, 700 and 800 degrees Cent. (932, 1,112, 1,292 and 1,472 degrees Fahr.), for a period of 30 minutes, followed either by slow cooling in the muffle furnace to normal temperature or by quenching in water, it is found that, whereas the tensile strength is not greatly increased, the elongation and reduction of area are increased to a remarkable extent. The range of temperature from 700 to 800 degrees Cent. (1,292 to 1,472 degrees Fahr.) appears to be the most favorable in securing the greatest increase in such properties.

In order to write a specification for the physical properties of a zinc bronze that would not be too difficult of fulfillment, without detriment to the public service, it is necesary to consider what may be reasonably expected of such a metal alloy as zinc bronze. It may readily be seen from the experimental work cited that a tensile strength of 30,000 pounds per square inch is not an unreasonable requirement.

With reference to the elongation desired, it is found that 15 per cent is difficult to obtain for specimens that represent small castings, because such castings, owing to their small sectional area, receive an initial chill which materially lowers the amount of possible elongation, and for such a casting the cast-to-size shape, on account of its relatively small section area, is naturally a representative type of test bar and should be chosen, but it is open for consideration whether 15 per cent elongation for such a specimen is not too severe to be expected in the course of ordinary practice. In all probability 14 per cent elongation and 13 per cent reduction of area is all that may reasonably be expected for this alloy when the casting to be tested has a large sectional area in proportion to its mass. If the sample be poured within the normal range of temperature—that is, from 1,115 to 1,260 degrees Cent. (2,039 to 2,300 degrees Fahr.)—the tensile strength of 30,000 pounds per square inch is not difficult to secure, and it is possible in a majority of cases to obtain an elongation of 15 per cent and a reduction of area of 14 per cent, and for such castings a cylindrical shape may be chosen.

Chill Cast Bars

If a casting is to be chill cast, while it is very easy to secure a tensile strength of 30,000 pounds per square inch, it is, on the other hand, impossible to secure an elongation of 15 per cent; in fact, an elongation of 4.5 per cent would be a fair equivalent for such a casting. This is because the initial stress is so great as to almost completely destroy the property of elongation. Now, if a chill bar is submitted to a proper heat treatment, either annealing or annealing and quenching as described, it is quite possible to obtain and reasonable to expect an elongation of 15 per cent.

Hence from the foregoing considerations it is fair to conclude that for small castings a tensile strength of 30,000 pounds per square inch with an elongation in 2 inches of 14 per cent and a corresponding reduction of area of 13 per cent may be required when using a cast-to-size shape test bar; for large castings, 30,000 pounds per square inch tensile strength, 15 per cent elongation in 2 inches, reduction of area 14 per cent; for chill castings, untreated, 30,000 pounds per square inch tensile strength, elongation 4.5 per cent, reduction of area 4 per cent; and for chill castings, heat treated, the same tensile strength, an elongation of 15 per cent, and a reduction of area of 14 per cent.

WEIGHT OF STEEL IN POUNDS FROM 1 TO 1,000 CUBIC INCHES.

	0	100	200	300	400	500	600	700	800	900
1	0.286	28.886	57.486	86.086	114.686	143.286	171.886	200.486	229.086	257.686
2	0.572	29.172	57.772	86.372	114.972	143.572	172.172	200.772	229.372	257.972
3	0.858	29.458	58.058	86.658	115.258	143.858	172.458	201.058	229.658	258.258
4	1.144	29.744	58.344	86.944	115.544	144.144	172.744	201.344	229.944	258.544
5	1.430	30.030	58.630	87.230	115.830	144.430	173.030	201.630	230.230	258.830
6	1.716	30.316	58.916	87.516	116.116	144.716	173.316	201.916	230.516	259.116
7	2.002	30.602	59.202	87.802	116.402	145.002	173.602	202.202	230.802	259.402
8	2.288	30.888	59.488	88.088	116.688	145.288	173.888	202.488	231.088	259.688
9	2.574	31.174	59.774	88.374	116.974	145.574	174.174	202.774	231.374	259.974
10	2.860	31.469	60.060	88.660	117.260	145.860	174.460	203.060	231.660	260.260
11	3.146	31.746	60.346	88.946	117.546	146.146	174.746	203.346	231.946	260.546
12	3.432	32.032	60.632	89.232	117.832	146.432	175.032	203.632	232.232	260.832
13	3.718	32.318	60.918	89.518	118.118	146.718	175.318	203.918	232.518	261.118
14	4.004	32.604	61.204	89.804	118.404	147,004	175.604	204.204	232.804	261.404
15	4.290	32.890	61.490	90.090	118.690	147.290	175.890	204.490	233.090	261.690
16	4.576	33.176	61.776	90.376	118.976	147.576	176.176	204.776	233.376	261.976
17	4.862	33.462	62.062	90.662	119.262	147.862	176.462	205.062	233.662	262.262
18	5.148	33.748	62.348	90.948	119.548	148.148	176.748	205.348	233.948	262.548
19	5.434	34.034	62.634	91.234	119.834	148.434	177.034	205.634	234.234	262.834
20	5.720	34.320	62.920	91.520	120.120	148.720	177.320	205.920	234.520	263.120
21	6.006	34.606	63.206	91.806	120.406	149.006	177.606	206.206	234.806	263.406
22	6.292	34.892	63.492	92.092	120.692	149.292	177.892	206.492	235.092	263.692
23	6.578	35.178	63.778	92.378	120.978	149.578	178.178	206.778	235.378	263.978
24	6.864	35.464	64.064	92.664	121.264	149.864	178.464	207.064	235.664	264.264
25	7.150	35.750	64.350	92.950	121.550	150.150	178.750	207.350	235.950	264.550
26	7.436	36.036	64.636	93.236	121.836	150.436	179.036	207.636	236.236	264.836
27	7.722	36.322	64.922	93.522	122.122	150.722	179.322	207.922	236.522	265.122
28	8.008	36.608	65.208	93.808	122.408	151.008	179.608	208.208	236.808	265.408
29	8.294	36.894	65.494	94.094	122.694	151.294	179.894	208.494	237.094	265.694
30	8.580	37.180	65.780	94.380	122.980	151.580	180.180	208.780	237.380	265.980
31	8.866	37.466	66.066	94.666	123.266	151.866	180.466	209.066	237.666	266.266
32	9.152	37.752	66.352	94.952	123.552	152.152	180.752	209.352	237.952	266.552
33	9.438	38.038	66.638	95.238	123.838	152.438	181.038	209.638	238.238	266.838
34	9.724	38.324	66.924	95.524	124.124	152.724	181.324	209.924	238.524	267.124
35	10.010	38.610	67.210	95.810	124.410	153.010	181.610	210.210	238.810	267.410
36	10.296	38.896	67.496	96.096	124.696	153.296	181.896	210.496	239.096	267.696
37	10.582	39.182	67.782	96.382	124.982	153.582	182.182	210.782	239.382	267.982
38	10.868	39.468	68.068	96.668	125.268	153.868	182.468	211.068	239.668	268.268
39	11.154	39.754	68.354	96.954	125.554	154.154	182.754	211.354	239.954	268.554
40	11.440	40.040	68.640	97.240	125.840	154.440	183.040	211.640	240.240	268.840
41	11.726	40.326	68.926	97.526	126.126	154.726	183.326	211.926	240.526	269.126
42	12.012	40.612	69.212	97.812	126.412	155.012	183.612	212.212	240.812	269.412
43	12.298	40.898	69.498	98.098	126.698	155.298	183.898	212.498	241.098	269.698
44	12.584	41.184	69.784	98.384	126.984	155.584	184.184	212.784	241.384	269.984
45	12.870	41.470	70.070	98.670	127.270	155.870	184.470	213.070	241.670	270.270
46	13.156	41.756	70.356	98.956	127.556	156.156	184.756	213.356	241.956	270.556
47	13.442	42.042	70.642	99.242	127.842	156.442	185.042	213.642	242.242	270.842
48	13.728	42.328	70.928	99.528	128.128	156.728	185.328	213.928	242.528	271.128
49	14.014	42.614	71.214	99.814	128.414	157.014	185.614	214.214	242.814	271.414
50	14.300	42.900	71.500	100.100	128.700	157.300	185.900	214.500	243.100	271.700

(Continued on Data Sheet No. 212.)

WEIGHT OF STEEL IN POUNDS PROM 1 TO 1,000 CUBIC INCHES.

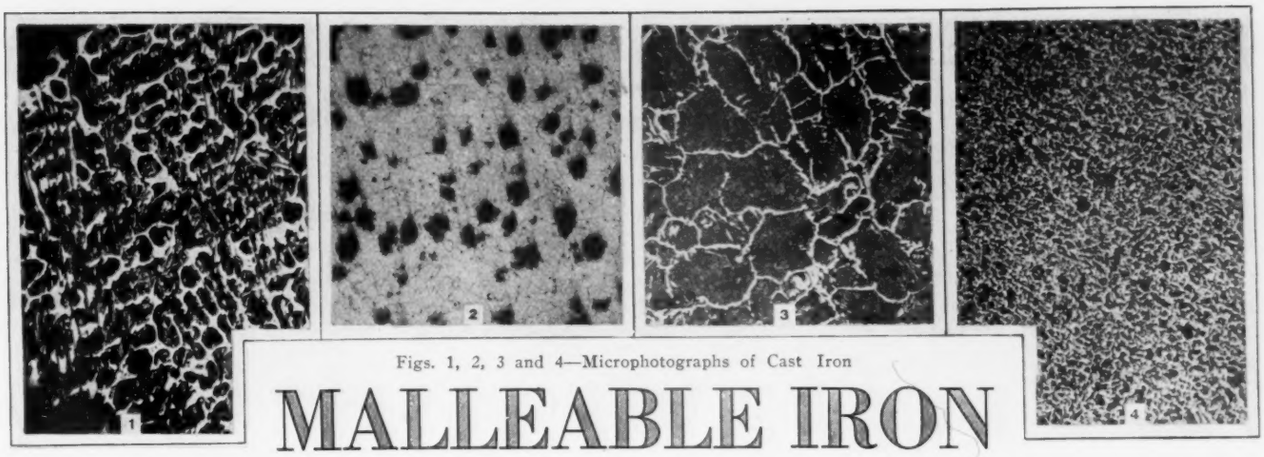
(Continued from Data Sheet No. 211.)

	0	100	200	300	400	500	600	700	800	900
51	14.586	43.186	71.786	100.386	128.986	157.586	186.186	214.786	243.386	271.986
52	14.872	43.472	72.072	100.672	129.272	157.872	186.472	215.072	243.672	272.272
53	15.158	43.758	72.358	100.958	129.558	158.158	186.758	215.358	243.958	272.558
54	15.444	44.044	72.644	101.244	129.844	158.444	187.044	215.644	244.244	272.844
55	15.730	44.300	72.930	101.530	130.130	158.730	187.330	215.930	244.530	273.130
56	16.016	44.616	73.216	101.816	130.416	159.016	187.616	216.216	244.816	273.416
57	16.302	44.902	73.502	102.102	130.702	159.302	187.902	216.502	245.102	273.702
58	16.588	45.188	73.788	102.388	130.988	159.588	188.188	216.788	245.388	273.988
59	16.874	45.474	74.074	102.674	131.274	159.874	188.474	217.074	245.674	274.274
60	17.160	45.760	74.360	102.960	131.560	160.160	188.760	217.360	245.960	274.560
61	17.446	46.046	74.646	103.246	131.846	160.446	189.046	217.646	246.246	274.846
62	17.732	46.332	74.932	103.532	132.132	160.732	189.332	217.932	246.532	275.132
63	18.018	46.618	75.218	103.818	132.418	161.018	189.618	218.218	246.818	275.418
64	18.304	46.904	75.504	104.104	132.704	161.304	189.904	218.504	247.104	275.704
65	18.590	47.190	75.790	104.390	132.990	161.590	190.190	218.790	247.390	275.990
66	18.876	47.476	76.076	104.676	133.276	161.876	190.476	219.076	247.676	276.276
67	19.162	47.762	76.362	104.962	133.562	162.162	190.762	219.362	247.962	276.562
68	19.448	48.048	76.648	105.248	133.848	162.448	191.048	219.648	248.248	276.848
69	19.734	48.334	76.934	105.534	134.134	162.734	191.334	219.934	248.534	277.134
70	20.020	48.620	77.220	105.820	134.420	163.020	191.620	220.220	248.820	277.420
71	20.306	48.906	77.506	106.106	134.706	163.306	191.906	220.506	249.106	277.706
72	20.592	49.192	77.792	106.392	134.992	163.592	192.192	220.792	249.392	277.992
73	20.878	49.478	78.078	106.678	135.278	163.878	192.478	221.078	249.678	278.278
74	21.164	49.764	78.364	106.964	135.564	164.164	192.764	221.364	249.964	278.564
75	21.450	50.050	78.650	107.250	135.850	164.450	193.050	221.650	250.250	278.850
76	21.736	50.336	78.936	107.536	136.136	164.736	193.336	221.936	250.536	279.136
77	22.022	50.622	79.222	107.822	136.422	165.022	193.622	222.222	250.822	279.422
78	22.308	50.908	79.508	108.108	136.708	165.308	193.908	222.508	251.108	279.708
79	22.594	51.194	79.794	108.394	136.994	165.594	194.194	222.794	251.394	279.994
80	22.880	51.480	80.080	108.680	137.280	165.880	194.480	223.080	251.680	280.280
81	23:166	51.766	80.336	108.966	137.566	166.166	194.766	223.366	251.966	280.566
82	23.452	52.052	80.652	109.252	137.852	166.452	195.052	223.652	252.252	280.852
83	23.738	52.338	80.938	109.538	138.138	166.738	195.338	223.938	252.538	281.138
84	24.024	52.624	81.224	109.824	138.424	167.024	195.624	224.224	252.824	281.424
85	24.310	52.910	81.510	110.110	138.710	167.310	195.910	224.510	253.110	281.710
86	24.596	53.196	81.796	110.396	138.996	167.596	196.196	224.796	253.396	281.996
87	24.882	53.482	82.082	110.682	139.282	167.882	196.482	225.082	253.682	282.282
88	25.168	53.768	82.368	110.968	139.568	168.168	196.768	225.368	253.968	282.568
89	25.454	54.054	82.654	111.254	139.854	168.454	197.054	225.654	254.254	282.854
90	25.740	54.340	82.940	111.540	140.140	168.740	197.340	225.940	254.540	283.140
91	26.026	54.626	83.226	111826	140.426	169.026	197.626	226.226	254.826	283.426
92	26.312	54.912	83.512	112.112	140.712	169.312	197.912	226.512	255.112	283.712
93	26.598	55.198	83.798	112.398	140.998	169.598	198.198	226.798	255.398	283.998
94	26.884	55.484	84.084	112.684	141.284	169.884	198.484	227.084	255.684	284.284
95	27.170	55.770	84.370	112.970	141.570	170.170	198.770	227.370	255.970	284.570
96	27.456	56.056	84.656	113.256	141.856	170.456	199.056	227.656	256.256	284.856
97	27.742	56.342	84.942	113.542	142.142	170.742	199.342	227.942	256.542	285.142
98	28.028	56.628	85.228	113.828	142.428	171.028	199.628	228.228	256.828	285.428
99	28.314	56.914	85.514	114.114	142.714	171.314	199.914	228.514	257.114	285.714
100	28.600	57.200	85.800	114.400	143.000	171.600	200.200	228.800	257.400	286.000

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, JUNE, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication



Figs. 1, 2, 3 and 4—Microphotographs of Cast Iron

MALLEABLE IRON

Its Characteristics, Uses and Abuses

By Enrique Touceda

AS A material of construction and as a component part of machines, the malleable iron casting has covered a wide field of usefulness, particularly during the past 40 years. The malleable iron industry has had a rapid growth, and at the present time there are some 130 different foundries in this country, with an aggregate capacity of close to a million tons per annum.

Research has shown that if carbon be introduced into a bath of pure iron it will dissolve, and after solidification has taken place it will be found that the carbon has combined chemically with a definite portion of the iron. This chemically combined carbon and iron is called carbide-of-iron, a constituent, which while made up of comparatively soft iron and very soft carbon, differs from both in that it is of extreme hardness and brittleness, and harder even than any constituent found in hardened steel. White iron contains this compound in large proportion, which serves to explain why such iron is so hard and brittle and so white in fracture. The foregoing holds true in all cases where carbon is introduced into a bath of pure iron, and also where the bath of iron may contain a limited amount of impurities, some of which actually favor the chemical union of the carbon and iron, some being inert to this action, and some tending to inhibit it if present in sufficient quantity.

A reasonable amount of phosphorus, for example, is inert to this action, sulphur and manganese favor it, while if silicon is present in excess of a certain quantity it prevents the union of the carbon with the iron and forces the carbon to separate out as graphitic flakes of irregular size, distributed more or less uniformly throughout the mass of metal.

Presence of Silicon

When there is sufficient silicon in the bath to cause this to happen, the fracture of the metal is invariably gray. In short, when we see an iron white in fracture, we can at least be sure of the fact that silicon is present in comparatively small amount and that the carbon present does not exist as such in the iron, but has combined with a definite part of the iron to form the hard and brittle constituent, carbide-of-iron: if the fracture is gray, we then know that most, if not all, of the carbon exists in an uncombined state, in the form of flakes as previously described, and that the silicon must have been high enough to have prevented the chemical union of the carbon with the iron.

FIG. 5—HAMMER FOR TESTING MALLEABLE WEDGES

The question of paramount interest is why a prolonged heating, at a certain temperature for a certain interval of time will change an extremely hard and brittle casting into one that is both soft and strong and whose fracture will be black. This we will undertake to explain in part by the aid of the microphotograph, Fig. 1, in which is shown the typical structure of white iron. The white areas are the hard and brittle constituent, carbide-of-iron, called by the metallographist cementite; the dark area is a mechanical mixture of this same constituent and of iron free from carbon, in the proportion of 12 per cent of the former to 88 per cent of the latter, called by the metallographist pearlite; the structure, therefore, actually consists of but two elemental substances, the hard carbide-of-iron and soft iron free from any carbon whatever.

We have referred to the conditions under which soft iron and very soft carbon unite to form a chemical compound as hard as quartz, but fortunately it has been found that this compound is not stable when exposed to a high temperature, and if it be heated long enough at such a temperaature it will split up into its two original soft constituents, which, when chemically united, caused it to be so hard, with the result that we

From a paper presented at a meeting of the Railway Club of Pittsburgh.

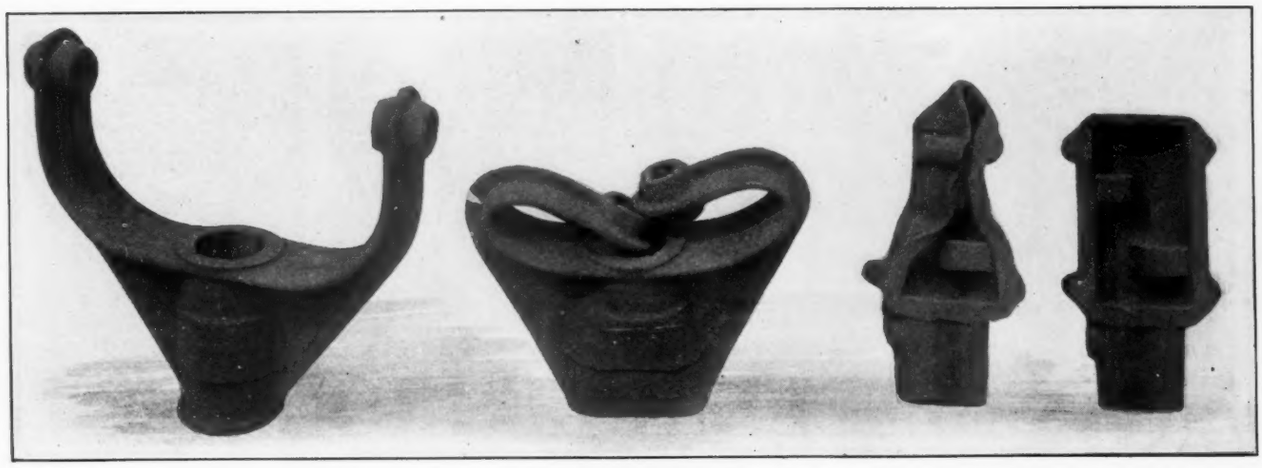


FIG. 6—LARGE AUTOMOBILE CASTINGS BEFORE AND AFTER BEING DISTORTED

obtain a structure consisting of a ground mass of very soft and ductile iron throughout which is uniformly distributed small nodules of free carbon, as can be plainly seen by reference to the microphotograph, Fig. 2. By comparing Fig. 1 with Fig. 2, the profound change that takes place through heat treatment will be immediately seen.

Control of the Product

While this seems easy enough to accomplish in practice, certain precautions must be exercised in connection with the composition of the white iron, for while it has been stated that the hard carbide is unstable under a high temperature, the statement must be modified somewhat by stipulating that the degree of stability depends largely upon the composition of the white iron. Either low silicon or low carbon seems to stabilize the carbide and prevent its being broken up into its two soft constituents by heat treatment, while high silicon and high carbon facilitate its decomposition, so we see that by a proper adjustment of these percentages, and attention to a few other details to which I will refer later, the manufacturer can control his product with intelligence.

Commercially, the malleable iron process is conducted in two steps, the first consisting in making a mixture of gray iron pig; sprue from some previous heat, and possibly an addition of steel in the event that the average carbon in the mixture is too high to produce the best results. In by far the largest majority of cases this mixture is melted in a reverberatory furnace, commonly known as an air furnace, from which it can be tapped in the course of some four or five hours for the average size heat. If during a heat, a test bar were poured when the charge was just melted, the fracture would be gray, because the silicon is still high enough to prevent the carbon from remaining permanently combined with the iron after solidification.

However, by holding the metal in the furnace, in order that through the oxidizing action of the furnace gases the silicon in the bath is gradually lessened, a point is finally reached where the chemical union of the carbon and iron is definitely attained, and if a bar is then poured and its fracture examined it will be found to be uniformly white throughout. When this stage of the operation has been reached, the metal should be very hot and easily fluid enough to pour the smallest castings without danger of misruns, while the silicon and carbon should be still high enough to make the carbide-of-iron as unstable as possible.

Fractured Test Bars

If through inadvertence the silicon or carbon is too low, then their initial percentages in the mixture were deficient.

In Figs. 8 and 9 are shown the fractured ends of a series of test bars that were poured at various stages of the heat, starting when the metal was just melted and afterwards at about 20-minute intervals until the furnace was ready to tap. It will be noted that the fractures grow progressively whiter from the all gray to the all white.

From what proceeds then, it is seen that the first step in the process is to make white iron castings from a mixture of gray iron, simply because

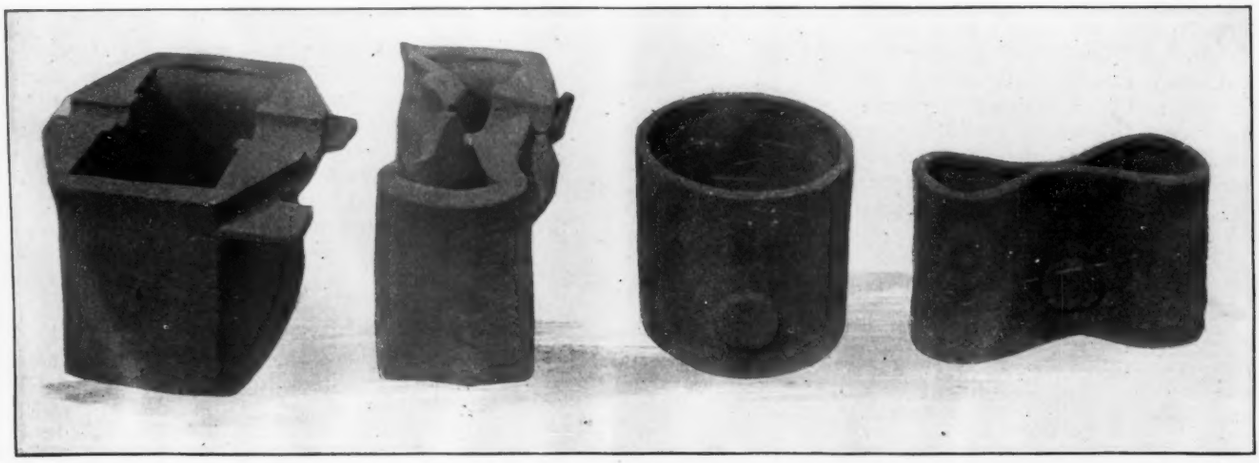


FIG. 7—ANOTHER GROUP OF AUTOMOBILE CASTINGS BEFORE AND AFTER DISTORTION

FIG. 8—FRACTURED ENDS OF TEST BARS POURED AT DIFFERENT INTERVALS DURING A HEAT

if we started with a white pig iron mixture the initial silicon would be so low that there would result a carbide-of-iron too stable to be successfully malleabilized, that is, changed by heat treatment into soft iron and free carbon.

The second step in the process consists in heating the white iron castings to the proper temperature for a certain length of time, for the purpose of making them soft and strong.

This is accomplished in practice, by placing them in the cast iron pots, where they are surrounded by a packing which should contain more or less oxide of iron. The joints and top of the pots are well luted in order to exclude air, and they are then charged into the annealing ovens. The packing serves the double purpose of protecting the castings from serious oxidation through contact with the air, while it still has inherent in its composition enough oxygen to enable it, through its intimate contact with the casting surfaces to eliminate some of the carbon from them without causing any scale to form on these surfaces. The castings are heated to at least 1,450 degrees Fahr. and are held at that temperature for at least 60 hours, when they are allowed to cool slowly for a period of at least three days.

Characteristics of Malleable Castings

The ideal malleable casting should possess the following characteristics:

First:—It should be free from blow-holes, in order that the engineer at all times is sure that the net section at any part of a casting is equal to the gross section at that part, and in order that the purchaser will feel confident that having spent a certain amount of money in machining it he will not be obliged to scrap the casting through the discovery of blow-holes.

Second:—The metal from which the casting is made should be very fluid when hot, and should have minimum contraction when cooling from solidification to atmospheric temperature.

Third:—The metal should machine easily at a high rate of speed and fair feed, the machined surface being glossy and smooth.

Fourth: — The structure should be what may be considered normal for the particular metal in question, and what is equally important the grain size should be the finest possible, otherwise the casting will fail to yield its maximum dependability under shock.

Fifth:—The metal being ductile, the closer the elastic limit approaches the ultimate strength, the better the metal.

Sixth: — The compressive strength should be high.

Seventh:—Under stress, the metal should flow easily when the elastic limit is exceeded, that is, it should act well under the drift test.

Eighth:—The castings should be capable of standing great abuse under shock.

Ninth:—The metal should be rust-resistant.

Tenth:—The cost per pound should be low.

We will consider these items in the order in which they have been set forth and make note of how the malleable iron casting measures up when compared with each particular item.

Freedom from blow holes:—In this connection I believe it will be freely acknowledged that the malleable casting can lay claim to superiority, for it is a rare occurrence to find one containing these costly and annoying defects.

That such should be the case should

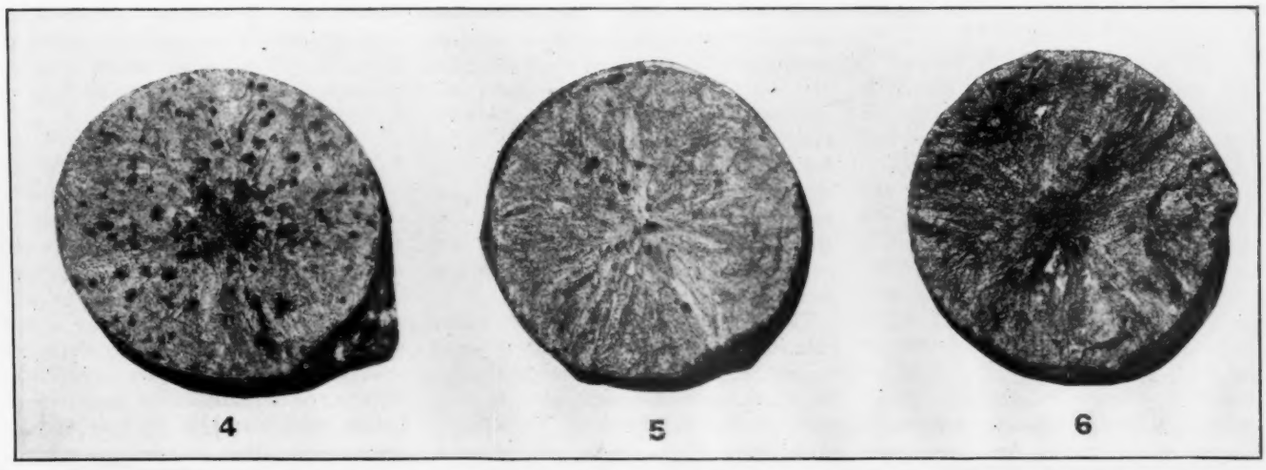


FIG. 9—THREE ADDITIONAL FRACTURED ENDS OF TEST BARS POURED AT DIFFERENT INTERVALS DURING A HEAT

be anticipated from the nature of the metal that enters into the composition of these castings. The silicon content is abundant, and the carbon very high, both factors making for soundness and a metal which easily frees itself from occluded gases.

The factors that make for fluidity are first carbon, then phosphorus and then silicon. These castings contain never less than 2.40 per cent carbon; for railway castings the silicon will average at the present time about 0.90 per cent, while owing to the fact that the structural composition of malleable is practically all iron, free from combined carbon, the phosphorus can safely be as high as 0.25 per cent, because it is the presence of combined carbon seemingly, that exaggerates the harmful effects of that element. Good castings can be made from this metal as thin as ordinary cardboard. The metal contracts ¼ inch to the foot when cooling from solidification to atmospheric temperature. This of course is high.

Machining properties: — The production engineer can bear testimony to the ease with which malleable iron can be machined, and the character of surface left after machining.

Rate of Cooling

Grain size:—All malleable sections as cast must of necessity be coarse in structure, that is their crystalline grains will be large in size, because the final grain size depends upon the temperature from which the metal cooled and the rate of cooling. Assuming that the rate of cooling has been the same in each case, the structure of a steel casting will be coarser than that of a malleable or gray iron casting, because its temperature of solidification is 400 or 500 degrees higher than that of either of the other two. It is however possible, though it adds to the expense, to get rid of this very coarse crystallization and replace it by crystalline grains of exceedingly fine size, by heating the casting to about 800 degrees Cent. and holding it at that temperature until the molecular rearrangement has been completed, thus converting a casting that would be wholly untrustworthy under shock, into one that would be entirely dependable. This operation is called grain refining or annealing.

Elastic Limit and Ultimate Strength

The elastic limit of a metal is measured by a load per square inch, such that when released, the tested specimen is found to have been stressed sufficiently to have been just permanently lengthened by thousandths of an inch only. It is the load per square inch that is just sufficient to permanently deform, and for this reason it is the factor that the engineer must know with certainty, because a high ultimate strength is of little special value to him if the structure he is building is going to alter in shape at a load far under that which will cause the members to break. Consequently, the nearer the elastic limit approaches the ultimate strength the more load the structure will withstand without fear of deformation, or in other words, it is better to have a metal with high elastic limit and a comparatively low ultimate strength, than to have one with low elastic limit and high ultimate strength, the metal being assumed to have sufficient ductility in each case not to be brittle. The elastic limit of fair quality malleable iron is easily 29,000 pounds per square inch, and its ultimate strength, in the majority of cases, will be in excess of 44,000 pounds per square inch.

The compressive strength of malleable iron is not high, being about equal to that of wrought iron or soft steel. Its elastic limit, in compression, is about equal to that in tension.

Metal should flow with facility under stress when the elastic limit is exceeded. This is a property that is of much value in a casting that is to be used in car construction, as it is often necessary that it be riveted or bolted to a frame or other part, and if the drilled or cored holes do not register with the ones to which it is to be connected, they must be able to stand drifting without danger.

That the metal in a malleable iron casting can withstand such treatment is illustrated in Fig. 10, which shows four plates ⅜-inch thick, through each of which has been drilled two ¾-inch holes. A drift pin then was inserted into one of the holes in each plate and the hole drifted until its surface was seen to check. By comparing the dimensions of the enlarged holes with the originals a fair idea may be had as to the ability of this metal to withstand such treatment.

In another test, a wedge was placed under the drop of a hammer, shown in Fig. 5. It was placed on the anvil, held upright, and tested by allowing the weight, which delivers a blow of 70-foot-pounds to fall on its thin end until fractured. More than 60 blows were required to break the wedge. The corrugations on the side of the wedge have been caused by portions of the metal slipping over contiguous parts. This indicates that when the metal is good, its ability to flow under excessive stress is remarkable.

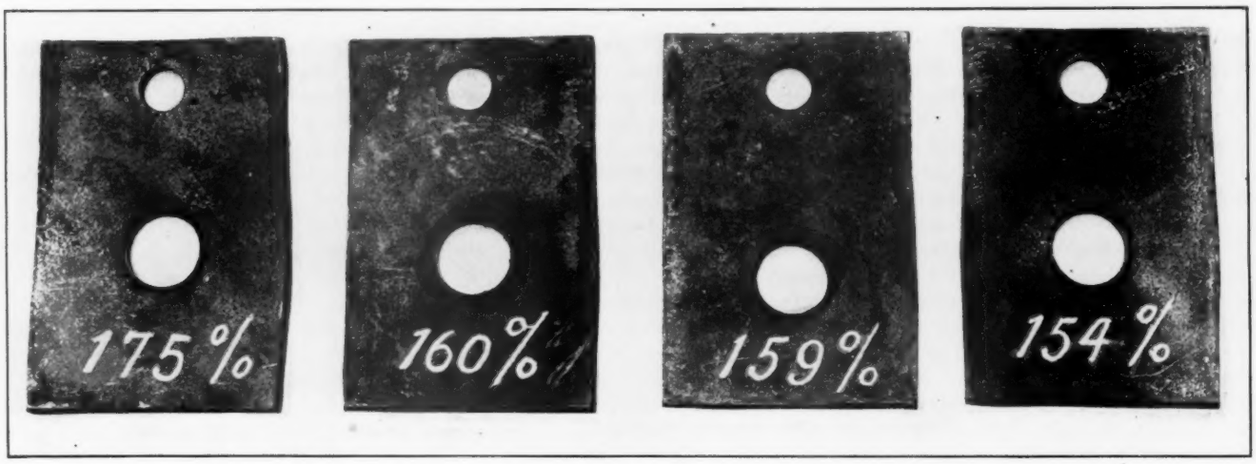


FIG. 10—TEST SHOWING HOW MALLEABLE IRON WITHSTANDS DRIFTING

Distortion of Malleable Castings

The question may now seem pertinent why malleable iron, in view of the large percentage of impurity contained in the metal, is able to withstand such punishment as the castings receive in service, or as shown by test bars tested dynamically? The test wedge previously referred to, was subjected to more than 50 blows of 70-foot-pounds each before failure took place by fracture and in some plants this is not exceptional. In Figs. 6 and 7 are shown large automobile

castings that have been violently sledged, and by a comparison of the distorted sections with their mates the severity of this treatment becomes manifest.

As the combined carbon in steel increases, its ductility declines, and combined carbon exaggerates the evil effects of phosphorus. You have been told that the structural composition of malleable iron consists of a mass made up of grains of iron containing no combined carbon, throughout which structure is uniformly distributed small nodules of free carbon. While these grains contain no combined carbon, they do of course contain the impurities that are in the iron other than carbon. These impurities, however, can be present in large amount without imparting brittleness and without affecting the ductility of the grains, due to the fact, presumably, that the grains contain no combined carbon. In a paper presented before the American Foundrymen's Association last fall, in which the phosphorus content of malleable iron was discussed, I reported upon wedges that had been subjected to as high as 40 blows of 70-foot-pounds each before failure took place, and in which the phosphorus content was close to 0.40 per cent. As the phosphorus increases beyond about 0.25 per cent it begins to alter the character of the fracture, giving it a more or less crystalline appearance. No such percentage is recommended, of course, but much has been said about the harmful effects of this element and I decided to make an investigation to ascertain whether this was true.

Resistance to Rust

I believe it will be conceded that in commercial castings, those resist rust better which are the lowest in combined carbon and manganese, and in malleable iron combined carbon is practically absent, while the manganese is comparatively low. I have no positive data to offer in this connection, but I believe that railway men in general consider that malleable iron tie plates, rail anchors, etc., rust less rapidly than similar castings when made of other ferrous material.

In malleable iron, the skin, in the majority of cases, is exactly similar to the skin that is on the soft steel casting after it has been annealed. As a matter of fact, no ferrous product can be heated in contact with the atmosphere present in the ordinary heating furnace without being given a decarbonized skin, and in this particular malleable iron is no exception. In a paper written for the American Foundrymen's Association I compared the strength of metal in skin and core, and it was demonstrated that in the case of a bar whose ultimate strength would run 41,000 pounds per square inch, if the strength was mainly in the skin, the metal in this skin would have to stand about 100,000 pounds per square inch to enable the bar as a whole to register 41,000 pounds. As a matter of fact, a great deal of malleable made for railroad work will average as high as 48,000 pounds per square inch, in which event the metal in the skin would be required to stand over 115,000 pounds per square inch to bring the bar as a whole up to the former figure.

Uniformity of Malleable Iron

It frequently is claimed that the structure of a malleable casting is not uniform throughout. There is just one way to ascertain the truth of this statement, and that is by the aid of the microscope. The structure of white iron is uniform no matter how thick the section. To anneal white iron, that is, to convert it into malleable iron, all that is necessary is to heat the iron up to a temperature of about 1,450 degrees Fahr., hold it to that temperature for 60 or more hours and allow it to cool very slowly for three days. The structure of the white iron consists of the two constituents, cementite and pearlite, and annealing in this case simply means the breaking-up of the hard carbide into soft iron and free carbon, by means of heat. I have stated that to anneal, all that is necessary is to heat to about 1,450 degrees Fahr. and hold at that temperature for a certain length of time. If this is all that is required, *and it is all,* then the only question involved as to the possibility of annealing any given section uniformly throughout lies in the ability to heat the section uniformly throughout, and as pieces of steel and other materials are being heated uniformly throughout their bulk, it is difficult to understand why malleable iron should be an exception to the rule. If then, any thickness of malleable iron can be heated uniformly throughout, it can be uniformly annealed; first, because the structure of the white iron is uniform throughout to start with and as the breaking-up takes place *in situ* the resultant structure must be uniform. However, to make a practical illustration that should satisfy the most skeptical, I requested a friend to cast a piece of white iron 2 inches in diameter and 6 inches long and to anneal it in exact accordance with his usual practice. This was done and after the receipt of the piece, a section was cut from it, polished and etched, and examined under the microscope. With the exception of the narrow, decarbonized border, the section is perfectly uniform throughout, and if the observer were uninformed as to the spot he was examining under the glass, he would be unable to designate, except by guess, whether he was looking at the center or at a spot in close proximity to the surface.

This also should serve to clear up the false statement, that when sections exceed 5/8 inch in thickness they cannot be properly annealed. It is true that during the annealing process, while the hard carbide is being broken up into soft iron and free carbon, some of the carbon is being removed through the oxidizing influence of the packing which surrounds the castings, and it is also true, for obvious reasons, that more carbon will be removed from a very thin section than from one much thicker, but the structure of the thin section will be uniform throughout and so also will the structure of the thicker one, though the latter will contain more total carbon. The difference in the amount of carbon removed from a piece as thin as 1/16 and one ½ inch would be considerable, but the difference between pieces ¼ and ½ inch thick would be inconsequential.

Chillers for Cast Iron Car Wheels

By G. S. Evans

Question:—We have received some complaint recently that the chillers for car wheels which we manufacture are too hard to machine. We would like to know the customary specifications for this grade of iron and whether or not Brinell hardness tests are required.

Answer:—I know of no specifications covering this class of castings, but have found that chillers made from semi-steel mixtures give excellent service. In the finished castings, these analyze as follows: Silicon, 1.00 to 1.50 per cent; manganese, 0.50 to 0.90 per cent; sulphur, 0.06 to 0.10 per cent; phosphorus, 0.40 per cent and carbon, 3.40 to 3.70 per cent. Chillers of this composition will show a Brinell hardness of about 150 at the center of the casting. This iron, cast into a 1¼-inch round test bar in a dry sand mold will show a hardness of about 200 in the center of the test bar and will machine nicely, giving a clean, smooth surface, which is essential to the long life of the chiller. The trouble refered to undoubtedly results from a chilled skin on the casting, resulting probably from a combination of high sulphur and low silicon. If this is the case, it can be overcome by increasing the manganese content of the mixture.

The general offices of the Silica Products Co., Chicago, have been removed from 140 North Dearborn street to the Cunard building.

The main office of the Goldschmidt Thermit Co., New York City, has been removed from 90 West street to the Equitable building, 120 Broadway.

How Practical Men Can Broaden Themselves

To Keep Pace With the Rapid Advancement in Foundry Practice Requires Constant Study and Asssociation With Men Who Are Foremost in the Van of Progress

By Russell R Clarke

TO THE question "How can we prevent tin and lead sweating in a copper-tin-lead alloy" a certain expert replied: "Use 0.25 per cent phosphorus, introducing it by using phosphor tin." The man answering that question didn't know.

To overcome trouble in running long, thin, yellow brass strips, a foreman ordered the mold slicked with plumbago. A practical man rose to remark that the tendency of plumbago to absorb dampness and chill metal might increase rather than relieve the difficulty. He was politely told to sit down and interest himself in his own affairs. Results established the wisdom of the practical suggestion and showed that foreman to be bigoted and non-receptive.

Experiencing difficulty with an infamiliar alloy, a foundryman sent his foreman on a mission of information to a foundry realizing results from the same alloy. The man entered the foundry as a mere visitor, didn't explain his mission, asked no direct questions and failed to get definite information. The trouble was he didn't want to admit his ignorance and depended on observation to get something without asking for it. He failed to observe closely and consequently left the foundry empty-handed. That man was an abject slave to a false sense of pride and was seriously handicapped thereby.

Better Talker Than Listener

Having cursed a bunch of defective high-lead castings until they started to oxidize, a man once sought our advice on the best manipulative practice. From a Christian motive we tried to relate to him the results of our most successful experience, but couldn't. The man insisted on doing all the talking in theorizing against our suggestions. Forgetting the motive, we left the man talk himself to silence and then withdrew. That man was a better talker than a listener.

On the earth's surface, near 42 degrees north and 77 degrees west, exists a foundry and a foundryman, both resembling very much what one might have seen 50 years ago. Everything in that plant is done in the good old-fashioned way. That foundryman has developed neither interest in, nor capacity for expansion. He is strictly a satisfied man.

Awaiting the return of the foreman, an assistant laid on the shelf on out-of-the-ordinary, hurry-up job. This man didn't lack the ability to do the job and, backed up by an emergency post, could go straight ahead to a successful finish. What he lacked was spirit. He was shy in self-confidence, had worked himself into a bad rut.

One molder warned another against insufficient anchorage to a pocket core in the cope of a mold and its liability to drop away in weighting-up the flask for pouring. The man said he'd take a chance. He did and it was a bad one. That man was careless.

A Foolish Foreman

To hurry things along, a foreman ordered a core used against the judgment of the coremaker, as to its state of dryness. That foreman was foolish.

A foundryman of experience and ability was requested by an outside foundry to locate serious metal trouble resulting in a heavy casting loss to them. The man went to the foundry, found the trouble due to oxidation arising from bad furnace and pouring practice. He assured the management that if instead of melting and pouring with no surface protection they would cover the metal well with crushed charcoal, the trouble would greatly diminish; whereupon the management purchased *two bushels* of charcoal. Those men were either incredulous or tight.

From actual experience we have thus chosen representatives of different types of men engaged in foundry work, and we do not hesitate to maintain that not one of these could be called broad-minded. Nor do we anticipate serious rupture with fact in venturing the opinion that for these, as well as all other narrowing qualities in men, ignorance or lack of enlightened common sense is chiefly responsible.

Briefly then, and as we see it, the whole argument of individual expansion is dominated by the premising truth that knowledge coupled with common sense is the base of all broadening. Both in the having and getting, these constitute the broad foundation. To seek diligently, to absorb intelligently and to apply logically valuable information, are the undoubted means to an enlarged and enlarging capacity for accomplishment in men. In this we do not want to be misunderstood. The contention cannot be that all well informed men are broad men, but rather and conversely, that all broad men are of necessity well informed. However, to wipe out inconsistencies and proceed on general principles, with little grace of reason, we might logically assume that all well-informed, sensible men are broad men.

From this viewpoint, broadening involves a dual activity, namely, developing common sense and furnishing the mind with valuable information. It means absolute independence from all natural and habitual qualities diametrically opposing all other forces of expansion. Among these qualities, for example, we note conceit, inconsistency, indifference, egotism, excitability, thoughtlessness, laziness, lack of appreciation of the rights, opinions and suggestions of others, and, in fact, all qualities hampering the free exercise of higher powers. To narrow limits and low levels many an otherwise promising man has been bound by these influences. In dealing with them, elimination is the only logical consideration. A bad quality is like a bad habit, the longer it is tolerated the worse it becomes. Treat with it on the same principle you would deal with a trouble-making man in your foundry—*get rid of it.*

No age of the world has witnessed such faithful application of mind to the development and practical application of scientific truth as the present. The result is rapid change in idea, a continual resetting of the industrial stage.

Day of Advancing Thought

In these days of advancing thought and revolutionary methods it becomes constantly necessary for the lay and practical man to check over his stock and store of information, scrap the antiquities of experience and go scouring the up-to-date markets of fact for new and more useful material. We say it becomes necessary, conditioning the necessity, of course, on the desire of the man to escape the dust and silence of the upper shelf and his willingness to sacrifice to those exacting demands executed by progress on the last of its disciples.

To all industrial experience it is a matter of fact and principle that neither men nor events stand still. Motion or change of motion is inevitable, either forward or backward, upward or downward, expanding or contracting, broadening or narrowing.

Neither producing systems nor industrial methods can remain constant. Formulated in the mists of conception and moving through eras of development, they fall prey to the suspicious of enlightenment, grossly contradict reason, and are ruled out of order in the reconvened parliaments of judgment. It has ever been thus and must be. Systems of yesterday are not those of today. Those of today will not be those of tomorrow. We know more today; they will know more tomorrow. They will learn and change as we have learned and changed. It is the learning of things, the fuller knowing of things, that accounts for the change in the doing of things. Such is the history of founding. By pathways of digression its thinkers and knowers have staged its eras of advancement and slanted its trunk lines of experience upward to high levels of accomplishment.

How to Get There

Bothering quite a few practical men, however, is how to get there and stay there; how to rise and expand with expanding possibilities. Lack of opportunity is a common lament, "the breaks of the game have been against them", "they never had a chance and have none". Granting all in life's heritage of misfortune, we can conclude, nevertheless, only that in these days of abounding knowledge and its unbridled publicity, the man who fails to either find or create his chance to broaden can offer no alibi entirely immune from suspicion.

Knowledge is power, power to see, think, learn and understand, the mind's power to do, derived from all it has ever done. Knowledge broadens thought, intensifies effort and vitalizes spirit. It makes for the usefulness of men and determines their relative worth. Along all lines, the man of the hour, the man of value, is the man who knows, or can figure out just exactly what to do and how to do it. He is the minute man of accomplishment, the insurance agent of results, the broad, eminently useful, indispensable man in all experience.

To enlighten then, is to broaden and the proposition at hand reduces thereby to a consideration of those means and sources by and from which the practical man in founding can increase and turn to good account his knowledge of the business.

All knowledge can be said to be one of three kinds. We either *know* a thing, know *how* to derive it, or *where* to get information on it. You may not know if less tin and more zinc will satisfy your alloy's requirements. You know how to find out, don't you? You don't know what cu, sn, ph, zn, etc., stand for. You don't know the individual function of the elements in your alloys. You don't know how to use a pyrometer. You don't know the alloy that will meet your specified physical requirements. You don't know from what cause your castings suddenly developed porosity. You don't know what the man meant when he said something about a *eutectic*. Well, you know *where* to find out, don't you? If you don't, awaken to the fact that there isn't a trade publication in the field today but is willing to hit any limit of effort to get you the information and print it for the asking. There isn't a broad man in the business who wouldn't be glad to help you. The author recently received a letter from a most sterling and recognized man, actually volunteering "to gladly answer any question we might have to ask". Only a few months ago we wrote a prominent authority, requesting his criticism on metallurgical data in our manuscript, and asked for his charges. In two days we had his answer, "Will be very glad to comply." His charges he forgot to mention. Next to knowing and applying, the chief joy of a broad man's experience is to diffuse his knowledge among those worthies asking and needing it.

The fact is with your own and other men's help there is no excuse for wearing the same old mental garments. They are out of style, threadbare and shabby. You need a new suit. Grow up, spread out and get a bigger one. Here are some of the ways you can do it:

I.—By exercising your own mental powers. That is, by thinking and planning to the limit of your capacity. Don't crawl off your own resources till you have to. Exhaust your own powers to furnish before bothering someone else for information. You will then appreciate and profit by it more. Exercise is culture's law. Breadth of mind is a matter of use of mind. No man need howl about what nature didn't give him. Nature gave him enough to start with, that's sure. The broadest and deepest men in founding today will remember their narrow and shallow days. What you have written in a book may tide you over a difficulty, but it will never broaden you until you have written it down in your mind.

Fact-Producing Foundry

Every man can make his own head a great fact-producing foundry. Within the walls of intellect he can heat, mold and pour forth thought and truth all his own. He can take the raw materials furnished by observation and memory and formulate homogeneous alloys of solid fact and principle. But he'll have to keep his eyes open and his head buzzing. Founding is replete with related truths. It is bad to melt copper and nickel together in a direct-casting alloy. This applies also to copper and manganese, lead and antimony, copper and zinc and any two elements widely differentiated in their fusing temperatures unless the lower, with profit, will dissolve the higher. Phosphorus works well with tin, so also with copper. It's all right in copper-tin, not bad with copper-tin-moderate-lead, but absolutely no good with copper-lead, copper-tin-high-lead, copper-zinc, copper-tin-zinc, or copper-tin-lead-zinc.

Experience the Great Teacher

Knowing is important, manner of knowing more so. Most all brass men know 88, 10 and 2, but not all the same. Some know it mechanically much the same as A. B. C., or July 4, 1776. Others conceive three piles of carefully weighed virgin metal, one red, one white, one bluish gray. Still others know a hard, tough casting of great strength and purity. But the man who *knows* 88, 10 and 2, knows a limpid mass of molten copper covered with charcoal and ready to receive its modifying agents, fairly feels it harden as the tin enters the mass, searching and quickening its very atoms. With the hiss and flare of the zinc he sees it toughen and its oxides rise with the fumes and pass away. And that's the broad way of knowing your alloys, knowing anything. Thinking and knowing why you do things and what will follow the doing in any proportions and under any conditions. There is no such thing as unrequited mental toil. We are broader and bigger for it regardless of material consequence. Even from its failures, new life and higher powers arise. Broad men are essentially broad not from accomplishment, but rather from capacity for accomplishment and that is the guaranteed and indestructible heritage of all honest effort, mental or physical.

II.—By getting the most from your experience. Experience is a great school. We all attend and pay our own tuition, so it's up to every man to get his money's worth. Some learn much from experience, others little; the difference is a personal matter. Some are studious attentive, others indifferent, careless. On the class you are in depends the benefit you will derive.

Experience is the sum total of small affairs, incidents often too trifling to speak about, little things occurring and recurring daily. On the surface of affairs mountains may arise here and there, but chiefly are knolls and hills ruffling the broad expanse. In the foundry, the apparent insignificance of an experience cannot argue against its importance. Everyone, good or bad, large or small, should be an object lesson to be thoroughly learned and never for-

gotten. A mistake once made is pardonable; repeated, negligible; persisted in, damnable.

Considerable of the author's experience has covered inspecting and checking the daily work of molders. From it he has learned much about men. To one class he has said: "You lost quite a few of those bodies yesterday." "How many?" "Six." "Alright, I'll make them up." Never a thought on the fault, what caused or would remedy it. He'd "make them up" and make the same mistake for all he knew or seemed to care. Another would walk to the scrap pile, count his six castings, curse his luck and walk away. Still another —though it seldom happened to him— would pick his castings out, look them over carefully, explore the defect thoroughly and then converse on the probable cause and remedy. In inspecting, we have found him often at our side, looking over his good castings and checking his judgment and practice against consequences. It's the eternal difference, the wide distinction between the man who profits by his mistakes and the man who doesn't, the man getting everything out of his experience and the man getting nothing.

III.—By learning to like the business. Personally we never chose it. By the trend of events we partially drifted, partially forced into it. We have often imagined ourselves a better something else and are positive of things we could like better. But we are in the business and mean to make the most of it. We believe the only way to get anything substantial out of the business is to put body, soul and spirit into it. An interested mind will make its own hard effort and receive its deepest and most lasting impressions thereby. Men taking delight in the daily experiences of founding will experience least difficulty in grapsing its truths and holding them. They will ever be on the heels of its developing thought and go after its newly discovered truth like a hungry hound after a bone. If you don't like, can't make yourself like the business, then your move is out of the business. One thing is sure, you needn't expect to cover very much of it if you go around cursing the fate that drove you to it.

Writing Your Experiences

IV.—By writing about your experiences for the benefit of others. "Writing maketh an exact man". It also produces a thinking man. If you want to know how much you really know about a thing, sit down under the consciousness that in black and white you are throwing yourself open to criticism or are liable to lead someone astray, and write it up. You will be surprised at the many little things of which you are in doubt and afraid to state until you look them up and make sure. That's when you start to broaden. You'll almost feel yourself widening. You are on the scent of fact absolute and unquestionable and nothing can stop you. In looking up one thing, you'll tumble onto another. Following out narrow lines, you'll switch into broad ones, harping on particulars. Your experiences have been valuable to you, they may be valuable to others. Write them up and send them to the editor. He may return them, but you'll still be ahead of the game and needn't care for that. The author has had more than one manuscript returned "with regrets" and he doesn't care who knows it.

Local Association Work

V.—By taking an active interest in the affairs of your local foundrymen's association. In your city there may not be one. That is a fact to be deplored and in which you are unfortunate. The principal cities have them, however, meeting periodically and surely you can get in touch with some one of them. The chief object of these meetings is to discuss subjects of interest to practical men. That means you will get in touch with many men's ideas and experiences and be given the opportunity of measuring your own with them. Comparison of ideas is always beneficial. It opens up broad avenues to new and varied features of consideration and weighs in the balance of composite judgment the value of all related details. Live ideas are like live wires, they meet with a flash and intelligence brightens. Nothing spurs a man to greater effort than honest contention. In the heat of argument great truths are forged, great energies expended. In open meeting a man says a certain thing will work. Another says he can't agree. It's an argument. Both cite from experience and then the deadlock. Interest quickens, opinion lines up, questions come as though from a machine gun. Suddenly it develops that the one man did some related thing the other didn't know about. Now that may have been the very thing you needed to know, the thing pinning you down, hemming you in, keeping you from broader views.

Organization is a power. The get-together idea is a broad one and is inspiring to contemplate.

Then, too, these regular monthly meetings become occasions of delight. They promote sociability and good feeling among foundrymen and these are valuable assets of experience. There is an air of brotherhood about them making men more willing to help each other and, in the last analysis, this is perhaps the most broadening of all influences. You will also find them great antidotes to discouragement. Many a poor wilting devil has carried the dust and disgust of a hard experience to the meeting place, encountered whole funds of optimism and good nature, forgotten his care, and gone home with a broader view and a tightening grip. The association needs you. You need the association. It's a mutual affair— so where's the argument against it?

VI.—By attending the annual foundrymen's conventions. Conventions are the 365-day clocks of progress. At each striking of the years we tarry briefly to review and record what we have accomplished and then wind up for another going. The convention is a great educator. It is a medium of publicity. Men gather there to see and compare what each other are thinking and doing. It is the market place of opinion and the bargain counters are full.

Every related phase of effort is represented there. The equipment and supply men are on hand. At great effort and expense they stage the concrete forms of crystallized thought spread out in panoramic view before you. Each new creation, every change in detail is indicated and described. You walk down those brainy aisles of exhibition, edging close to the up-to-date and working models of inventive genius and side-lined with intelligent men eager to enlighten you and you expand with every step. It's an inspiring, broadening experience and you can't afford to miss it. Some say it's an advertisement, "they only want to sell." Well, don't you have to buy and isn't it better and cheaper to go to a localized center than run all over the country, trying to find out what you want and where to get it?

The Big Game of Experience

At the convention you meet the captains of industry and get a line on the big guns of experience. It certainly loosens a fellow up to see and hear them in action, these 42-centimeters of intellect and experience. They use the best of ammunition, aim true, shoot straight and hit hard. Whether you will it or no, it will broaden you to hear them talk. The best and broadest men in the business attend the foundrymen's convention and the man neglecting the opportunity plays a narrow and losing game.

VII.—By reading best books and current literature on the subject. Some say Cadmus invented books. Others credit the Phoenicians. Whoever did, deserves a monument.

Suppose for a few legalizing dollars

a great fortune representing long years of toil to amass were offered you, what would you do? You'd dig up the fee and consider yourself lucky, wouldn't you? Well, that's what a good book on founding means to the foundryman. It means by toil and midnight oil some one, perhaps many men, have gone over long years of experience and selected the treasures of thought and truth to be written down in a book.

Good books subserve a dual purpose. They train us to think logically and furnish valuable information. They should be read with this object in view. Manner of thought has much to do with its breadth. If you persist in thinking in a rattle-brained, chaotic way, you need never hope to become much of a thinker.

Good authors are good thinkers. They exercise great care in observing logical order of presentment to make the subject more easily grasped and understood. If we read and study them carefully, we will fall into the habit and greatly profit by it.

Books are like electric light bulbs. They give no light until screwed into a live socket. Your head is the socket, your thought is the current. Reading without reflecting is like eating without digesting. It may go through you, but it will neither make red blood nor build up your mental body. It is more likely to sour on you and give you the headache. Figuratively speaking, it was said of John Milton that he never played for a mere passive listener. No good author does. They expect you to think with them, being only too glad to assist you in thinking beyond them.

Reading and Understanding

In reading, some men rely largely on memory. It's a mistake. In practice, memory isn't ultra important, it's the understanding that counts. A good understanding of things will often give momery a vacation. We have often been told we have a good memory. We haven't. We have a good understanding, if anything. We remember a time when we couldn't remember a lesson from one flogging time until the next. We had a defective understanding of things. The written page may contain words to you undefined. Never pass them by unexplored. They bear distinctly on the author's meaning and will help you in later reading. Did you ever notice with what monotonous frequency you run onto words whose meaning you have neglected to explore?

Reading is an art, an accomplishment realized by the doing. Of Roosevelt we have heard it said he can absorb a whole page at a glance. We believe it. We know a man who can approximate it. It indicates the mind's state of receptivity. In white-hot metal a solid pig will dissolve as a snowflake in the river. In a white-hot mind, solid thought and fact will do the same thing.

Mere pastime reading is of little value. To me reading is working and if I have time to play I want to play outdoors. As in everything else, the benefit derived is commensurate with the energy expended.

Books give us truth developed. Current literature posts us on fact developing which instills the spirit of progress within us. Personally we are not prone to spend money for nothing. We want value received and we consider we get it many times over in the material furnished us by the trade monthlies. We are at present taking six and were prices to double would drop none.

Sentinels of Progress

Trade publications are the sentinels of progress. They study and make public the advancement of men. They represent vast expenditures of time, money and effort in search and announcement of up-to-date matters of fact and experience. They bristle with ideas and opinions caught fresh from the master minds of effort. They make great studies of wants and conditions, they cover every phase of related interest. Along all lines their efforts are driven. They are great mediums for comparison of ideas. They reflect the best thought of the day and open their columns to its discussion. They invite criticism and appreciate comment. They prompt questions and answer them. They study your difficulties and solve them. They solicit your valuable thought and experience and pay you for them. They recognize every man in every related position and cater to his interests impartially. They stake off broad fields of possibility and give you an option on them. To get the most out of a publication you want to read and study it. It's a great text book. Everything is valuable or it wouldn't be there. Now and then you may think you discover an error and probably you do. "To err is human," and most writers are more or less human. We know of very few with whom in some matter of detail we could not at least disagree. The finding of an error or contrary opinion is an opportunity to broaden. The man stating or entertaining it will be glad to publicly ackowledge and part with it in favor of a better. Write him. He'll thank you and perhaps enlighten you. You have nothing to gain and are a narrow man in attempting to ridicule him. In this we are not pleading a personal case, having never encountered such experience. We merely enunciate a principle to us most sterling. We can refer you to a college text book on chemistry stating bell metal an alloy of copper and zinc. We never said anything to anybody concerning it except the publishers. That we considered enough.

In the foundry, every day, somebody is going up against something. Many of them ask the trade magazines for information and help, and they publish it in their questions and answers department. That is a most valuable field of study. It doesn't matter whether the subject is of immediate concern to you or not, it won't hurt you, it will broaden you to know it. We study the questions and answers of all foundry publications as carefully as though the questions were our own and we know we are broader for it. To date one trade paper has answered thousands of questions and others are equally prominent.

Then, too, we have the illustrated advertisements of the magazine and they embody a world of ideas. "Every picture tells a story." There are many machines and many types of foundry equipment we never saw. Yet we understand their principles and can describe them. We saw a picture, read a description of them in the magazines.

The magazines are replete with accounts of different practical experiences —just such things as you are liable to fall down on. Some broad-minded fellow hits onto something, ploughs through it, feels justly proud of it and writes it up. The magazines pay him for it and hand it to you for a mere nothing. Won't that broaden you?

Experimenting

VIII.—By experimenting. The author used to wonder what kind of a metal would result from 50 per cent copper, 50 per cent tin; from aluminum and zinc, aluminum and tin, conservative proportions of copper, tin, lead, nickel, zinc, etc. He knows now, though nobody told him.

Knowledge is defined as a condition of certitude. What we read we accept on faith or reason. We know it better and surer if we experience it. We can experience it by experimenting on it. The questions and answers affords a broad opportunity along this line. Many answers, assertive of something of which you are not sure, involve processes sufficiently practical to enable you to try it. You will then know for sure and be broader in consequence. We read once that galena would support lead incorporation in copper. We wondered if it really would. We didn't know. We tried it and know just exactly what it will do. You can always find some disposition of the alloy ex-

perimented with, and the process involves no great expense.

IX.—By getting out and seeing what other foundrymen are doing in their foundries. It's a poor foundry possessing no individuality and a poor foundryman without a notion or two of his own. By getting out and seeing how other fellows are doing it you will learn not only new things, but also new and varied features of things you already know. In the middle west we once walked into one of the most pauperized brass foundries we ever saw, yet right then and there we learned something about casting brass on iron face plates.

A narrow man stays at home and thinks he knows it all. A broad man gets out and sees what's going on and the poorest of the poor is the firm that can't give its responsibles this opportunity now and then.

Finally, don't be ashamed of what you don't know or swelled-headed over what you do know. Be rather ashamed of what you are not trying to find out and big-hearted with what you possess.

These are not all the ways of broadening, just a few of them. We are interested in ways and means to this end. Perhaps some one has discovered some we don't know of. We would appreciate hearing from them if they have.

The branch office of the Independent Pneumatic Tool Co., Atlanta, Ga., has been removed to Birmingham, Ala., where offices have been established in the Jefferson County Bank building.

Snyder Furnaces Abroad

W. K. Booth, vice president of the Snyder Electric Furnace Co., Chicago, recently returned from England where he designed and installed several electric furnaces for the manufacture of ferro-silicon. These furnaces will produce this alloy with a content of 97.25 per cent silicon. In addition to these four furnaces, Mr. Booth, before his return, had well under way the installation of two electric furnaces, each capable of melting 12 tons of steel in 24 hours. These are installed in the plant of Thwaite Bros., Bradford, Eng., and are lined to produce basic steel. A third furnace with a capacity of 12 tons in 24 hours was purchased by Thomas Summerson & Sons, Darlington, Eng., while the furnace sold to the Daimler Motor Car Co. will be used for melting gray iron for automobile cylinders. A special type of furnace with a capacity of 5 tons of basic steel in 24 hours was sold to the National Steel Foundry Co., Leven, Fife, Scotland. During the next few months the Snyder Electric Furnace Co. will have at least nine furnaces in operation in England.

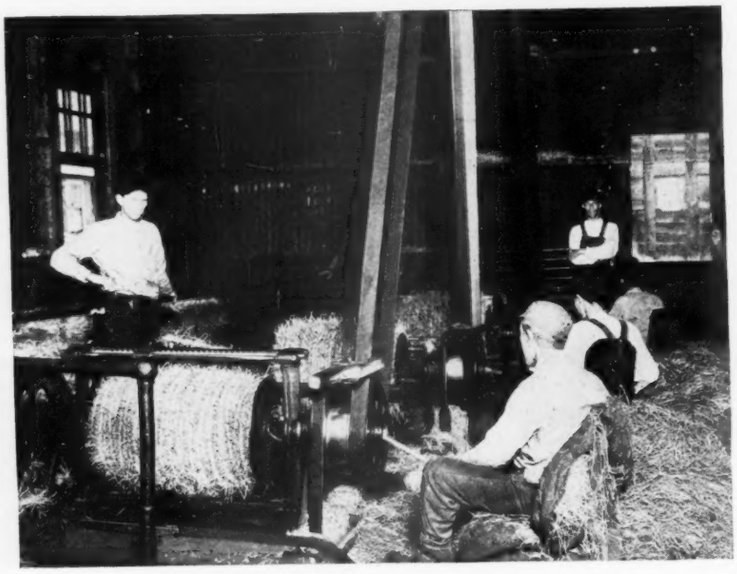
Philadelphia Foundrymen Discuss Fire Brick Problems

At the May meeting of the Philadelphia Foundrymen's Association, W. S. Quigley gave a demonstration of the heat-resisting and binding qualities of a high-temperature furnace cement manufactured by the Quigley Furnace Specialties Co., 26 Cortlandt street, New York. This cement, which is designed especially for use as a mortar between fire bricks, is said to form a permanent bond which remains unaltered up to temperatures sufficiently high to melt the bricks themselves. The tests were made in an experimental electric furnace furnished by the Electric Heating Apparatus Co., New York, the temperatures being measured by a pyrometer manufactured by the Thwing Instrument Co., Philadelphia. Temperatures up to 3,000 degrees Fahr. were employed.

In conclusion Mr. Quigley stated: "All fire brick or tile should be selected true to size and shape; warped or mutilated pieces should not be used. There is a concern in this country that does a considerable volume of business by marketing especially selected fire brick and tiles, all of which are trimmed and trued. This company employs a corps of masons to cut and fit the shapes to templates so as to insure accuracy. The cost is high owing to freight, rehandling and fitting, but the results seem to prove the wisdom of this practice."

The firm name of the Peerless Parting Co., Ottawa, Ill., manufacturer of parting compounds, has been changed to the Wedron Silica Co. The personnel of this firm, however, remains unchanged.

A Substitute for Hay Rope in a Southern Foundry



TWISTING AND REELING EXCELSIOR ROPE

FOR making the cores for the smaller sizes of cast iron pipe no improvement on the time-honored method of winding the core bar with rope and a clay mixture has yet been devised. The rope forms a multitude of vents for the passage of gases through the core. In most pipe foundries these ropes are made of hay. The increasing number of farmers who have been taught in agricultural colleges to charge "all the traffic will bear" has resulted in the establishment of high prices for hay. Pipe manufacturers, therefore, have been seeking substitutes. The American Cast Iron Pipe Co., Birmingham, Ala., has found that excelsior serves very well and costs much less than hay. It also makes a very strong rope. The accompanying illustration shows how excelsior rope is automatically twisted and reeled.

Electric Furnace Construction and Operation---I

A Comprehensive Discussion of the Design and Manipulation of This New Steel-Making Medium for the Foundryman, With Details of the Electrical Problems Involved

By James H Gray

ELECTRICITY as a source of heat has been considered seriously in connection with the manufacture of steel only in recent years because, as a simple competitor of coal and gas, it is expensive. When, however, it was recognized that, by the use of heat free from the contamination of oxidizing conditions, chemical reactions and metallurgical operations were made possible which could not be performed by our older methods, and that not only could the dead melting operation of the crucible be duplicated, but that materials containing objectionable ingredients could be refined, and give a steel equal to the best quality known, then the use and development of the electric steel furnace grew rapidly.

So far invention has given us two methods only of applying electric heat to the steel furnace—the direct application of the arc to the charge in the arc furnace, and the generation of heat in the metallic charge by means of induced electric currents in the induction furnace. In the arc furnace, the molten charge is cooler than the slag and this is a desirable condition, as the slag has a higher melting point than the steel. In the induction furnace the heat of the slag is derived from the steel, while the space above the slag is quite cool. Thus while it is possible to acquire a temperature and fluidity of the slag by which certain chemical reactions may be carried on between the slag and the metal in the induction furnace, this cannot be accomplished as readily and satisfactorily as it can be done in the arc furnace.

Induction Steel Furnace

While the arc steel furnace is merely a hearth on which steel is made, the source of heat being the arc, just as flame is used in other furnaces, the induction steel furnace is really an electrical apparatus, as it contains within itself the transformers which induce the heat in the charge.

I consider that the construction and further development of the induction furnace is more the task of the electrical expert than it is of the practical furnace man or the mechanical engineer. This paper is confined then to the arc type of electric steel furnace.

An ideal electric furnace is one whose shape is a sphere. The charge would be a metallic sphere and would be located in the center of the spherical furnace much as the yolk of a hard boiled egg is enclosed by the white of the egg. The walls of the furnace would be perfect insulators of heat and perfect conductors of electric current. The amount of current applied to the charge would then be so great that it would be melted in an exceedingly short time. When the heat was finished, the furnace would split open and the charge be instantaneously ejected.

Furnace a Compromise

Very practical considerations permit us to only distantly approach this ideal. The charge when molten will lie in a pool and the bottom of the furnace must be saucer shaped. Doors have to be opened for the purposes of charging, manipulating slags, taking tests and making alloy additions. If we insulate the furnace too well, we find that our refractory lining will melt. To introduce electric current we have to avail ourselves of the kind of current and the means of handling it most adaptable to our conditions. Therefore, our furnace is a compromise in many ways.

For materials suitable for making the furnace hearth or bottom, we are practically confined to two—magnesia and silica. The basic electric furnace, just as the basic open-hearth furnace, permits the use of a basic slag covering for the metal bath which, reacting chemically with impurities in the metal, remove them. By the use of oxides in the slag phosphorus may be removed, but the electric furnace does more; it can work under reducing or deoxidizing conditions which make it possible to remove sulphur and the still more objectionable element oxygen.

With an acid furnace phosphorus and sulphur cannot be removed, but excellent steel can be made from high grade materials by dead melting, as in the crucible, and by deoxidizing the steel by the aid of the nascent silicon, which is reduced from the silica of the slag. However, there are two difficulties in this connection. If a truly reducing or deoxidizing condition is maintained, so much silica is liable to be reduced to silicon that the steel will be too high in silicon. If oxides are introduced to burn out the excess silicon, or worse yet, if no slag is carried except that coming from the melted rust of the scrap, we have no better condition than that existing in the acid open-hearth furnace.

The best basic hearth is made by placing next to the steel shell of the furnace magnesia brick and then forming a hearth of bowl shape by sintering-in grain magnesia which is a species of calcined magnesite. The most suitable kind of magnesia is that which contains in its natural form a certain amount of iron oxide, as pure magnesia is too refractory for the purpose. Even with this material, it is advisable to mix with it from 10 to 20 per cent of open-hearth slag to make it sinter or frit more readily.

One method of burning-in the hearth is to make a plastic mass of magnesia, slag, hot tar and pitch, and ram in the hearth to the desired outline with hot rammers. Then a bed of coke is placed in the furnace and the electrodes lowered upon it. On the passage of current, small arcs form throughout the mass of coke and it soon becomes incandescent. After maintaining this high heat on the hearth for several days, it is burned to a sufficient depth to make it serviceable, but the sintering cannot be forced as far as the brickwork of the bottom.

Making the Furnace Bottom

I have found a more satisfactory method to be that of placing a thin layer of magnesia over the magnesia brick and bringing this up to a white heat by means of the arcs. When a sample gouged from the bottom shows that it is no longer granular, but a plastic mass, another layer of magnesia is added and sintered to the first, and the process is repeated until layer by layer the hearth is built up to the desired contour. It is then one monolithic block. Of course, this procedure is possible only in those furnaces which have the electrodes so disposed as to admit of it and requires about 36 hours. It is the same method which is employed in making open-

Presented at the Atlantic City meeting of the American Foundrymen's Association.

hearth bottoms in America, except that with the heat of the electric arc the time consumed is much less in electric furnace.

Having a good bottom to start with, the corrosion about the slag line is repaired after each heat by throwing in a few shovelfuls of dolomite, either calcined or raw. Such a bottom lasts for an indefinite number of years without ever removing it for complete replacement. Dolomite, which is a combination of magnesia and lime, can also be used for making the hearth and even lime has been used for fettling. This is done in Europe more than in America.

The Acid Bottom

To make an acid hearth, it has been found preferable to build-up the entire hearth to the correct contour of silica brick and dust it over with silica sand. Silica brick is less expensive than magnesia brick and it is more difficult to burn-in a satisfactory bottom of sand than one of magnesia.

The prime consideration in securing a sound and lasting hearth is to have it as simple as possible. It should not be complicated by any water-cooled, air-cooled or semi-molten metallic parts or connection; neither should the bottom be composed of or contain conducting but non-metallic substances. These devices, which break up the continuity of the bottom, may be put up within a hearth of small size, but those of us who have had experience with open-hearth furnaces know what "steel in the bottom" or "a hole in the bottom" means in loss of production and higher costs with a hearth of any considerable dimensions.

The walls of a basic furnace above the slag line may be made of silica, magnesia or chrome brick. Magnesia brick is the most satisfactory as regards its life and the effect on banks and slag of drippings from the walls, but its high cost will equal the cost of brick and labor for several silica walls. Chrome brick, although too soft a material under heat to be used in high walls, may be used in the low walls of an electric furnace very successfully, provided that there is no objection to a small quantity of chrome being reduced from its oxide into the steel which is specified for any particular purpose. As the chrome ore, of which the brick is made, is neutral to bases and acids, it does not cut the banks when it drips on them, and the chrome brick walls are not cut by the molten silica which runs over them from the fluxing of the silica roof, as is the case with magnesia brick. Silica brick, though cheaper than the other two, of course, is not affected by the molten silica running over the skew-back from the roof. However, it is attacked by lime fumes volatilized from the slag by the heat of the arc.

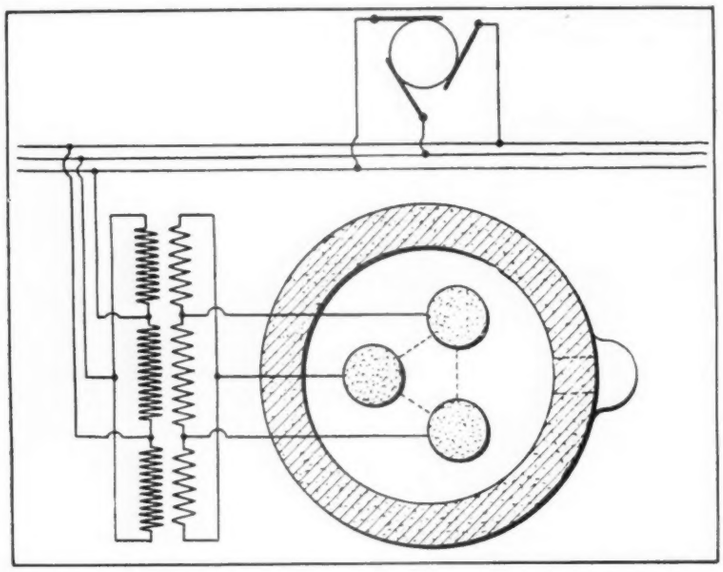


FIG. 1—CIRCULAR FURNACE WITH THREE ELECTRODES

Material for Walls

Also if, because of opening the doors too often, or having to shut the furnace down at intervals, the electrodes become pointed by oxidation, or if the arc be too long, thus causing heat to be reflected by the slag to the walls, the silica brick, being less refractory than the two other kinds, is melted readily and runs down over the basic banks into the slag, cutting the banks and often causing the slag to be too acid. It is apparent then that the material to be used for the walls must be chosen after considering the various conditions under which any given furnace has to operate.

The roof can be of silica only, as no basic material has yet been discovered which will stand in the form of an arch of any appreciable span without spalling. The material for lining the acid furnace is silica throughout. Various other materials have been suggested for electric furnace work, but either their excessive cost or their failure to serve the purpose have prevented their general use.

Thickness of Walls and Roof

In my ideal furnace I mention perfect heat insulation. Unfortunately, the refractories at our disposal will not stand up under constantly applied high temperature. Heat applied at one end of a brick will cause it to melt, unless the heat is drawn away at the other end of the brick. Paradoxical though it may seem, ingenuity must be used to ventilate and draw heat away from the brickwork, instead of trying to insulate it. In the electric arc we have a source of heat of 100 per cent efficiency. To make the efficiency of the furnace as high as possible, we must endeavor to concentrate the heat in the charge, bury the arc in the charge while melting, and hold it down on the bath after melting and to accomplish the work in the shortest time practicable. Then when we have compelled our kilowatts to do their utmost in the charge, the excess or unused heat should be carried away rapidly enough to leave intact the refractories which form the furnace. It is by these means that the charge and not the furnace is made to absorb the majority of the heat, and the radiation is reduced, not by insulation, but by cutting down the time during which it acts.

A practicable thickness for walls is from 13 to 18 inches. I consider the best thickness for the roof to be 9 inches. It can be observed that when a furnace is new and the walls and the roof are at their thickest the consumption of kilowatts is smaller than later in the campaign, but it is also noticeable that the first few inches of brickwork go much faster than the last, and that we get the real service out of the brickwork after it is thin enough so that heat is rapidly conducted away to the atmosphere. An extreme application of this principle is seen in certain Girod furnaces, where the roof is only 4 inches thick and where an air blast is used to cool and preserve the brickwork.

Many expedients have been tried to provide for the arc electric furnace

suitable electrodes and connections, but for steel furnaces all have given away to simple carbon electrodes made in sections of convenient length, joined together by a nipple or screw thread, which permits them to be fed into the furnace through the electrode holder so as to consume the whole electrode without loss by butts. The forms of carbon used are either graphite or amorphous carbon. The graphite electrode may be graphitized after it is molded of amorphous carbon, or it may be molded of graphite in the granular form.

The advantages of the graphite electrode are its high conductivity and its greater freedom from breakage and its ease of manipulation. The fact that it costs more than the amorphous carbon electrode prohibits its use where a few cents' saving per ton of steel is considered important, as is the case with production on a large scale. Graphite is also a better conductor of heat, as well as of electricity, and accordingly the reduction in size of electrode by the use of graphite is not all gain.

The Ideal Furnace

In my ideal furnace I considered the medium which enveloped the charge to be not only a perfect refractory, but also one big electrode. The nearest approach to this condition would be to have the bottom entirely made of carbon, and have the roof consist of one very large electrode, there being no walls to the furnace. In a steel furnace carbon cannot be used for the bottom, as the steel would soon be pig iron. The second compromise with the ideal would be to have the charge entirely covered with an electrode divided by insulating planes into two or three sections, according to the kind of current to be used. This arrangement being impracticable, the next suggestion would be a multitude of small arcs in a great cluster which would entirely cover the charge. In this way the charge would be attacked at as many points and over as great an area as possible. Of course, the question of regulating apparatus, holders, roof coolers, accessibility to the furnace for taking tests and making additions, restrains us again.

The best solution is to have the electrodes as large as practicable, considering what is obtainable commercially and what will harmonize with the other necessities of good furnace design, and to increase the number of electrodes when these considerations and the size of the bath demand it. Carbon, when kept away from oxygen, is one of the very best refractories, and if the arc can be maintained under a relatively large surface of carbon its heat is thrown down on the bath in the form of a hemisphere. If the electrode be very small and pointed, the arc radiates heat in all directions as a sphere, and the roof and walls suffer. In those furnaces where the electrodes enter the furnace horizontally this is also true, and it has been found extremely difficult to maintain a roof on those of small size, and impossible on those of large size. The consumption of kilowatts per ton of steel produced is greater with this type of furnace, where the heat is radiated from the arc equally upward and downward.

Assuming that the furnace is of such size that the minimum number of electrodes will be used, the number will depend on the kind of current and on whether or not electric connections through the bottom are used. With bottom connections a single-phase furnace will require one electrode; 2-phase, two electrodes, and 3-phase, three electrodes. If no bottom connections are used, that is, if the electrodes are vertical and are in series, the current passing from one to the other through the bath after striking arcs with the bath, or if the electrodes are arranged so as to maintain the arc above and clear of the bath, then a single-phase furnace requires two electrodes; 2-phase, four electrodes, and 3-phase, three electrodes.

Bottom Connection

It must be borne in mind that a bottom connection is not a substitute for an electrode, though the number of electrodes may be thereby reduced because a certain number of amperes must be carried through the electrodes to furnish a given number of kilowatts, and the cross-section of electrodes must in both cases be the same for the same kilowatts and arc voltage. It will be noted that for a 3-phase furnace the number of electrodes is the same whether a bottom connection is used or not.

Furnace with Three Electrodes

The furnace illustrated in Fig. 1 is circular and encloses three electrodes. As the electrodes are arranged in a triangle, the natural form of the furnace would be triangular, but the circular form gives a stronger structure and more practical design. The electrodes are connected in delta with the transformers and are arranged with the pouring-out spout between two electrodes to facilitate slagging off. Fig. 2 shows an arrangement of six electrodes. Here two triangles are placed with their bases parallel and the triangular form of the furnace is more nearly adhered to considering each half of the furnace by itself. The two groups of electrodes are connected in delta with two separate groups of transformers. This arrangement is better than having the six electrodes form a rectangle, for thus we have a rectangular furnace, and with the viscous basic slags of the basic electric process it is better to avoid corners or level places where the slag will rest while the heat is being poured from the furnace. With these slags there is always a tendency for the bottom to build-up, and if an accumulation of old slag from previous heats comes off the banks into the slag of some later heat there is trouble. This trouble is not experienced either in the bowl-shaped or triangular hearth. Fig. 3 shows an arrangement for 10 electrodes in the form of two triangles with a square between them. The central group of transformers is connected with the Scott's connection so as to give 2-phase current, each phase of which passes through two of the electrodes of the square in series. Fig. 4 shows an arrangement for 12 electrodes connected to four sets of transformers. The two middle triangles may be

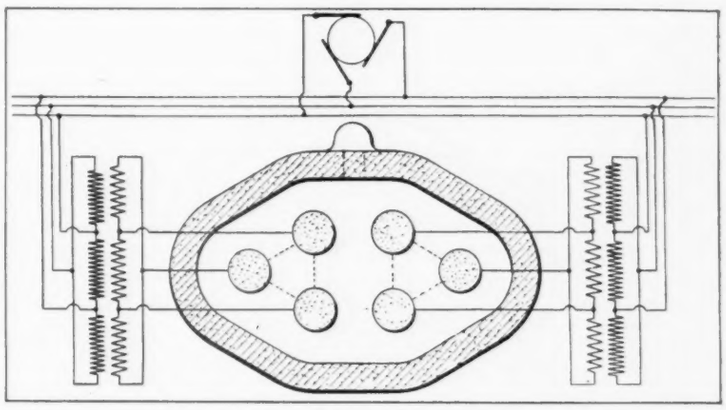


FIG. 2—ARRANGEMENT OF FURNACE WITH SIX ELECTRODES

connected either as indicated by dotted lines or the triangles may lap over each other with two corner electrodes connected to one central electrode on the opposite side of the rectangle. Both arrangements have been found to work equally well.

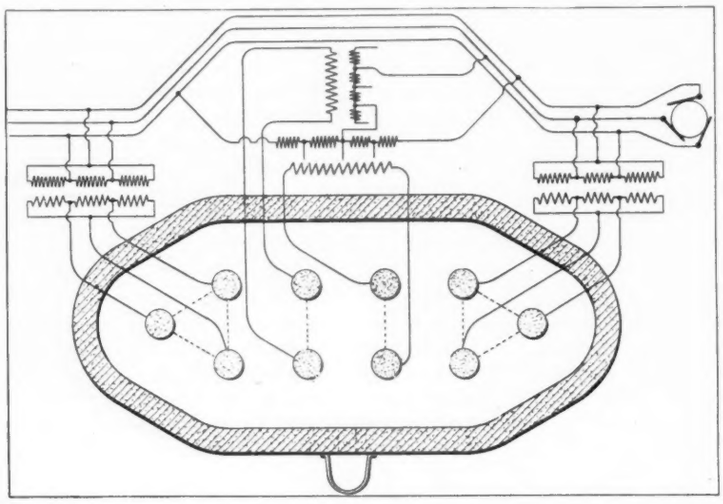


FIG. 3—TEN ELECTRODES ARRANGED IN FORM OF TWO TRIANGLES WITH A SQUARE BETWEEN

The question as to the current phase which we may best use is practically settled for us, in America at least, because the current furnished by practically all power companies and that made in large industrial establishments is 3-phase. The reasons for the general adoption of this form of current are economic and will rule until some better method of generating and transmitting electric current is found. Supposing that the size of the furnace has gone beyond that in which one set of electrodes may be used, and that 3-phase current will be used, I give in Figs. 1, 2, 3 and 4 suggestions for the grouping of electrodes.

Sizes of Electrodes

Table 1 shows sizes of electrodes which have been found to be satisfactory in practice. It will be noticed that the cross-section of the electrode is not in absolute proportion to the size of the furnace. Account is taken of the commercial sizes of electrodes available, furnace design and increase in current required per ton charge for furnaces of smaller size.

The electrode holder should be so constructed as to form a good electric connection with the electrode and at the same time be easily tightened and loosened. It should be water-cooled so as to prevent arcing at the connection, which destroys both cooler and electrode. If the holder is not cooled it expands with heat faster than the electrode and the latter is permitted to slip down. On very small furnaces where the weight of the electrode is small and the preservation of the holder of little moment, the water-cooling may be omitted. Surrounding the electrode and resting on the roof should be a water-cooled collar or ring. The cold surface thus afforded causes the fumes which arise from the bath to condense on it and form a smut which seals the opening between the electrode and the collar. Thus the furnace is made more nearly airtight. Without this device the flame escaping through the opening would destroy the electrode and the size of the opening would gradually increase.

The arc electric furnace may use either direct or alternating current. For commercial reasons alternating current is almost exclusively used and, for the same reasons, the use of 3-phase current is becoming more general than that of single-phase or 2-phase current. The voltage of the current used may be any voltage furnished by the power house because it is transformed at the furnace to the voltage required in the furnace, which is relatively low. As the arc is a form of electrical resistance, the voltage employed depends on the length of the arc desired. If we adopt the principle that the arc should be confined between the bath and the end of an electrode of considerable area, then the arc should be as short as possible, at the same time keeping the carbon electrode out of all contact with the molten bath. This condition is obtained by a voltage of about 45 volts at the arc. Where the electrodes are in series, then the voltage across the busbars is 100. If the electrodes are in series with the bottom connections, then the voltage is from 50 to 75.

When melting ferro-manganese, where it is desirable to volatilize as little of the manganese in the arc as possible, the arc is made so short that it is practically hidden in the slag, and the arc voltage is just above that at which an arc can be struck, namely, from 25 to 30 volts. Where a long arc is desired, for instance, in furnaces having horizontal electrodes and in which no arc is struck with the bath, and where an arc 8 or more inches long is desired, arc voltages vary from 100 to over 200 volts.

Static Transformers

For the transformation of current from high voltage to the low voltage used by the furnace static transformers are preferable. Rotary transformers have frequently been used for this purpose in Europe, but as the loss of power in the rotary transformers is 15 per cent or more as against 1½ per cent in the static transformer, the difference in cost of current at the furnace is considerable. Also, the rotary is one more piece of machinery to look after.

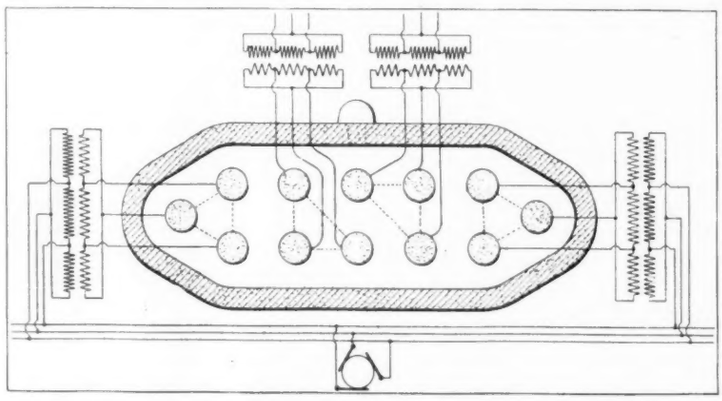


FIG. 4—TWELVE ELECTRODES CONNECTED TO FOUR SETS OF TRANSFORMERS

Separate transformers may be used for each phase, or all the phases may be included in one transformer, as,

for instance, one 3-phase transformer for three electrodes. The single transformer is slightly cheaper, but an injury to one phase of the transformer may mean the ruin of the other phases, which would not be the case with separate transformers for each phase. Two transformers may be used on a 3-phase circuit by running on open delta, but the advantage is questionable. Either air-cooled or water-cooled transformers may be used. If the latter, the water after passing through the transformer may be passed through the water-cooling system of the furnace. The telltale of the furnace may be used as that of the transformers and is always within view of the furnace operator. If the water ceases to flow through the furnace coolers, the current would naturally be cut off, thus automatically protecting the transformers.

Form of Conductor

With furnaces of larger size, where heavy currents up to 18,000 amperes per phase are used, and with other conditions seldom found in ordinary electrical work, the doctors do not always agree as to the best form of conductor and the amount of copper which should be used to carry these heavy currents from the transformer to the electrodes. The most satisfactory construction is that of busbars instead of insulated cables, and I am using on the furnace a cross-section corresponding to 800 amperes per square inch of copper. Where flexible cables are used in order that the furnace may be tilted, the cables should be bare cables and may also be loaded to 800 amperes per 1,000,000 C.M. Of course, it is common practice to load copper heavier than this, but as both the bars on the furnace and the flexible cables are in warm places, and it is not comfortable to have cables twisting and bars rattling under heavy loads or surges of current, I think the investment in copper is advisable. If aluminum conductors be used, sizes will be varied to conform to the use of this metal. Table II shows how the proportions of copper mentioned have been successfully applied to furnaces of various sizes.

Referring to the transformer capacity used with the various sizes of furnaces in Table II, it will be noted that for the 6, 10 and 15-ton sizes 200 kva. per ton are used, and that for the smaller sizes the kva. per ton increases as the size of the furnace decreases. So long as current is on the furnace, loss of energy by heat radiation goes on, and as the consumption of kilowatts per ton of product is affected by the size of the divisor and as the radiation per ton is greater in the small furnaces, it is advisable to cut down the time during which radiation acts by making quicker heats on the smaller furnaces. Also in general the requirements of the steelmaker, making small heats, demand that the heats come close together.

Table II.

PROPORTIONS OF COPPER SUCCESSFULLY APPLIED TO VARIOUS SIZED FURNACES

Size of furnace, tons.	Transformer capacity, Kva.	Amperes per phase.	Sq. in. copper per phase.	Number of ¼ in. copper bars per phase.	Number of C. M. flexible cables per phase.
1	375	2,250	3	2—6	4— 750,000 C. M.
2	600	3,600	5	4—5	6— 800,000 C. M.
3	750	4,500	6	4—6	6—1,000,000 C. M.
4	900	5,400	7	4—7	8—1,000,000 C. M.
6	1,200	7,200	9	6—6	6—2,000,000 C. M.
10	2,000	12,000	16	8—8	8—2,000,000 C. M.
15	3,000	18,000	24	12—8	12—2,000,000 C. M.

Table I

SIZE OF ELECTRODES FOUND SATISFACTORY IN PRACTICE

Size of furnace, tons.	Transformer capacity, Kva.	Amperes, each phase.	Amorphous carbon — Size of electrodes.	Amorphous carbon — Amperes per sq. in. of electrodes.	Graphite — Size of electrodes.	Graphite — Amperes per sq. in. of electrodes.
1	375	2,250	8	45	4	180
2	600	3,600	12	32	6	128
3	750	4,500	14	29	7	116
4	900	5,400	14	35	7	140
6	1,200	7,200	17	32	8	143
10	2,000	12,000	20	38	10	152
15	3,000	18,000	24	40	12	160

Handling Crucibles Made with American Clay

Owing to the inability of crucible makers to obtain German clay for their mixtures, they are compelled to resort to the use of American clays and the resultant pots must be handled with greater care than those made with German clay as a constituent. The crucibles should be annealed carefully, should be kept in stock for a considerable period before they are placed in the furnaces and pots of smaller capacity should be employed. Prior to the war it was the custom of crucible users to retain a six months' supply in stock which insured thorough seasoning and satisfactory annealing. Today, however, owing to the scarcity of crucibles, they cannot be seasoned as they are used almost as soon as they are received. The pots should not be cooled too rapidly nor should they be heated too quickly, as they are liable to crack as a result of sudden expansion and contraction. It is recommended that the pot be returned to the furnace while it is still hot and this will enable it to cool slowly after the fire has been withdrawn. It also is suggested that crucibles of a smaller size than those formerly employed will give a larger number of heats than crucibles of the same size as those used when German clay was available. For example, if a foundry used a No. 400 pot it is advisable to try a No. 300 or a No. 225 and in a shop where No. 60 crucibles are customarily used, a No. 45 or No. 50 should be tried. By following these suggestions better results can be obtained from the use of pots made with American clays.

Facing Capacity Increased

The capacity of the facing mill operated at Stockertown, Pa., by T. P. Kelly & Co., Inc., New York City, has been increased to 30 tons per day by the installation of additional machinery. This plant is located on a site of 8½ acres, and during the past few years a concrete warehouse was built to insure an adequate supply of various materials for immediate shipment to the foundry trade.

The copper produced in Pennsylvania is a by-product separated from magnetic ores of the Cornwall iron mine, in Lebanon county. A small production of lead in 1915 was reported from Mercer county.

The firm name of Wonham, Sanger & Bates, Inc., 17 Battery place, New York City, has been changed to Wonham, Bates & Goode, Inc.

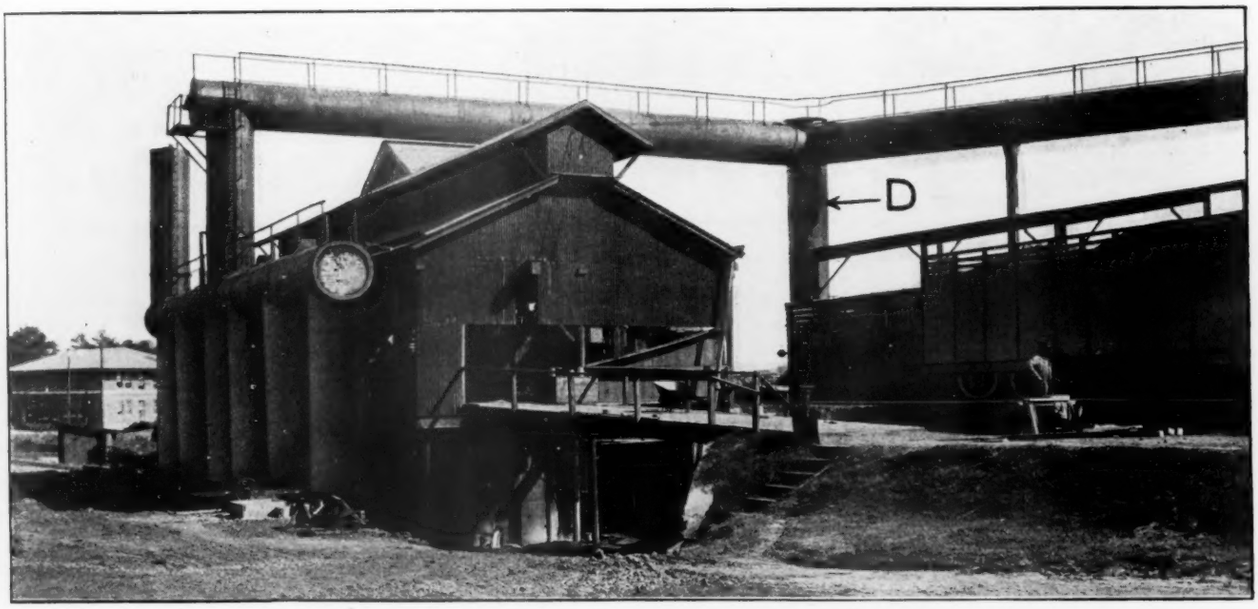


Fig. 1—General View of Producer Gas Plant at Works of American Cast Iron Pipe Co., Birmingham, Ala., Showing Arrangement of Off-Take, Manifold and Overhead Gas Main

How Producer Gas Made Four-Inch Pipe Possible

By H Cole Estep

BY USING producer gas instead of coke for drying molds, the American Cast Iron Pipe Co., Birmingham, Ala., has made the manufacture of 4-inch cast iron pipe commercially feasible. In most modern pipe shops, where circular pits served by jib cranes are employed, the molds are dried in the pit where they are poured. When using a direct coke fire for this purpose, the American Cast Iron Pipe Co. found that over 10 hours were required to dry 4-inch molds. This resulted in so limited a production, one entire shift being wasted in drying the molds, that it was not possible to sell the product at a price low enough to compete satisfactorily with similar sizes of steel or wrought iron pipe. The molds for 4-inch pipe are much more difficult to dry than those for the larger sizes, owing to the relatively low ratio between the surface exposed and the total volume of sand in the flask. Nevertheless, an extensive demand has been created for cast iron pipe in sizes under 6 inches, due to a large extent to its corrosion-resisting properties. By the employment of gas instead of coke, the time required for drying the molds has been divided by three, resulting in practically tripled production per pit. This increased tonnage has made it possible to market 4-inch pipe on a satisfactorily competitive basis.

Also the use of producer gas in connection with the manufacture of cast iron pipe brings other, incidental advantages. The workmen have a decided preference for gas, not only because much less manual labor is involved than with coke, but also because the temperature of the pits is greatly reduced. With direct firing, the heat in the pits becomes almost unbearable in the summer time. This is specially true in the south. The fact that the pits are cooler when gas is used shows, also, that much less heat is wasted when this form of fuel is burned. Furthermore, if gas is used instead of coke for mold drying, it also may be employed, with virtually no increased

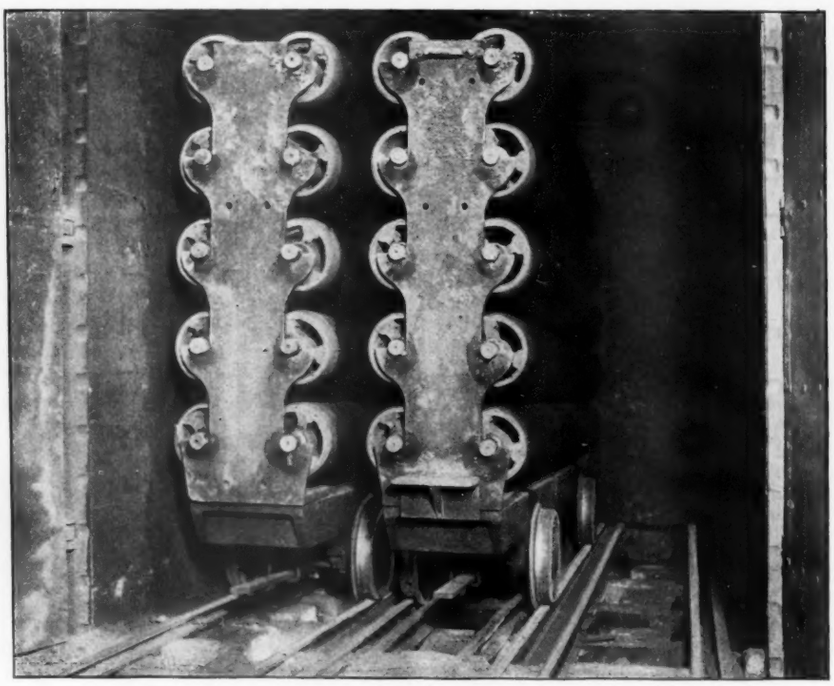


FIG. 2—ONE OF THE PRODUCER GAS FIRED CORE OVENS AT PLANT OF AMERICAN CAST IRON PIPE CO.

expense, for heating core ovens, resulting in appreciably reduced charges for labor and attendance. Few foundrymen appreciate the cost of maintaining several, scattered coke fires under core ovens and ordinary mold-drying ovens. The American Cast Iron Pipe Co. uses producer gas for all drying and heating purposes throughout its works, which is one of the largest in the country.

The experience of this company indicates that producer gas has reduced the cost of drying pipe molds 40 per cent. On 4-inch pipe, the time required for the drying operation has been cut from approximately 12 hours to three hours. From seven to eight hours are consumed in drying 6-inch pipe molds with coke; gas has reduced this time also to about three hours. Proportionate savings are possible in drying molds for the larger sizes of pipe. In addition, the gas greatly fecilitates drying the molds for 16-foot, extra-length pipe. Long-length pipe has certain inherent advantages, inasmuch as it contains only 330 instead of 440 joints per mile of line. It is exceedingly difficult, however, to dry 16-foot pipe molds with coke. Gas solves the problem, inasmuch as with this fuel it is possible to heat the mold uniformly throughout its entire length. The American Cast Iron Pipe Co. was the pioneer manufacturer of long-length pipe in the United States.

Labor costs are considerably less with producer gas. When burning coke in its pits, the American Cast Iron Pipe Co. employed eight firemen; at present, with gas, only three are required.

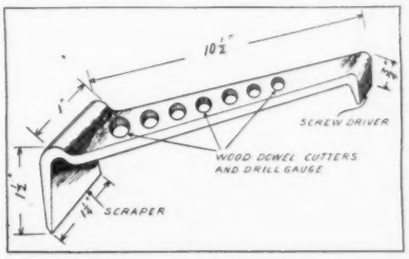
Six Producers Installed

The general arrangement of the producer gas plant of the American Cast Iron Pipe Co. is shown in Fig. 1. Six producers have been installed. They are 13 feet in outside diameter. The diameter inside of lining is 10 feet. This plant turns out 7,000,000 cubic feet of gas per day. The producers, which are arranged in a row, are sheltered by a steel-frame building sheathed with corrugated steel siding. The producer off-takes connect with a 60-inch brick-lined manifold which extends alongside the producer house parallel with the eaves. The manifold delivers the gas to a 60-inch overhead main, shown clearly in Fig. 1. This main conveys it to the pipe foundry. One of the several dust-catchers with which the gas main is provided is shown at *D*, Fig. 1. As this illustration indicates, the dust-catchers are of very simple construction. Workmen who may have occasion to inspect the gas main are protected from falling off by a steel hand rail. The producers are hand-fired and poked and the fuel is handled in buggies.

The gas is made from coke containing 70 per cent fixed carbon, 5 per cent volatile matter, 18 per cent ash and from 7 to 12 per cent water. Coke is used instead of gas coal in order to procure a dry, clean gas. If coal gas is used raw, tar deposits soon clog up the mains, pipes and burners. Such gas may, of course, be cleaned with water, but in this case, the gas absorbs considerable moisture which is liberated on combustion. The steam thus formed condenses in the molds and causes trouble. In the core ovens it is absorbed by the cores. Therefore a dry, clean gas is necessary and this is obtained at the American plant by using coke in the producers. Practically no trouble is experienced from tar deposits. On rare occasions some of the smaller pipes are taken down and cleaned. The burners, also, are cleaned at intervals. Most of the solid particles carried over by the gas are separated-out by the dust-catchers.

Analysis of the Gas

Steam is admitted to the producers with the air blast. Also Eynom-Evans blowers are employed. Under these conditions, an average analysis of the gas is as follows:



COMBINATION SCRAPER AND SCREW DRIVER FOR PATTERNMAKERS

	Per Cent
Carbon dioxide, (CO_2)	5.20
Oxygen, (O_2)	0.30
Carbon monoxide, (CO)	26.90
Hydrogen, (H_2)	10.50
Methane, (CH_4)	0.60
Nitrogen, (N)	56.50

This gas contains an average of 134.7 British thermal units per cubic foot. Approximately 64.0 cubic feet of gas are obtained per pound of coke, and therefore 8,621 British thermal units are recovered in the gas, per pound of coke. On leaving the producers, the gas has an average temperature of 450 to 500 degrees Cent. This is reduced to about 100 degrees Cent. in the pipe foundry. Only the large 60-inch main leading from the producer house is lined with fire brick. The smaller distributing mains in the foundry are unlined.

The gas burners present no unusual features of construction. In the 4-inch pipe pits the flasks are arranged in pairs so that two flasks are heated by one burner. Each flask, in this size, contains two molds. The molds are dried in about three hours.

One of the gas-fired core ovens at the plant of the American Cast Iron Pipe Co. is shown in Fig. 2. This oven contains three tracks and has a total capacity of 30 cores. The cores are suspended by arbors in racks of special construction. The gas burners are arranged in three rows underneath the tracks and tests have demonstrated that the ovens are heated uniformly. The gas is controlled entirely from the outside of the oven.

The producer gas apparatus at this plant was designed and installed under the supervision of J. F. Kent, general manager, American Cast Iron Pipe Co, Birmingham, Ala.

A Combination Patternmaker's Tool

By M. E. Duggan

It is poor patternmaking practice to use an edge tool or plane to remove glue, sand or varnish from glued joints, old patterns, bench tops, etc. In the accompanying illustration is shown a scraper which will prove satisfactory for such work. The holes in the handle are handy and practical for forming dowel pins, while the screw driver at the end of the handle serves two purposes, namely as a stop for the hand when using the scraper and also for stubborn screws in core boxes and patterns. The dimensions given will provide for a scraper of handy size for general use and it is convenient for storage in the tool chest. It is made of tool steel and is tempered. The screw driver feature also will be found to be handy for machinists' use and takes the place of a special tool.

Annual Meeting of Newark Foundrymen

At the annual meeting of the Newark Foundrymen's Association held at Newark, N. J., May 3, officers for the ensuing year were reelected as follows: President, H. P. McDonald, Snead & Co. Iron Works, Jersey City, N. J.; vice president, James Flockhart, Maher & Flockhart, Newark; treasurer, James Campbell, Maher & Flockhart,, and secretary, J. S. Kinne, Riverside Steel Casting Co., Newark. The executive committee consists of James Flockhart, Maher & Flockhart; Louis Sacks, Louis Sacks Iron Foundry; G. Hannay, Oscar Barnett Foundry Co.; Arthur E. Barlow, Barlow Foundry Co., and E. M. Taggart, J. W. Paxson Co. The meeting was addressed by T. E. Austin, assistant manager of the crane department of the Niles-Bement-Pond Co., Philadelphia, who talked on foundry crane installations.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG.	Prince's Chambers
CHICAGO	1521 Lytton Bldg.
CINCINNATI	404 Johnston Bldg.
NEW YORK	508 West Street Bldg.
PITTSBURGH	2148-49 Oliver Bldg.
WASHINGTON, D. C.	206 Corcoran Bldg.

SUBSCRIPTION

United States and Mexico	$1.00 a year
Canada	$1.50 a year
Great Britain and other Foreign Countries	Eight Shillings
Single Copies	15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 10th of the month preceding date of publication.

ENTERED AT THE POST OFFICE AT CLEVELAND AS SECOND CLASS MATTER

Copyright 1916, by the Penton Publishing Co.

Contents

CASTING HUBS ONTO WHEELS IN A SPECIALTY SHOP..... 211
THE SHORTAGE OF GRAPHITE..... 213
DETROIT FOUNDRYMEN BANQUET AND ELECT OFFICERS..... 214
PLANNING A FOUNDRY FROM ITS FUTURE OPERATIONS..... 215
RECLAIMING MOLDING SAND IN AN EASTERN PLANT..... 218
ANOTHER TWO-TON OPEN-HEARTH TO BE INSTALLED..... 219
A SHORT CUT IN WELDING ROLLING MILL PINIONS..... 220
BUSHING GRINDING WHEELS..... 221
STANDARDIZING CORE PRINTS..... 222
A CASTING FOR AMMONIA FITTINGS..... 222
SIZE OF CUPOLA FOR A STOVE PLATE FOUNDRY..... 222
CHEMISTRY FOR THE BRASS FOUNDRYMAN—I..... 223
FLUX FOR YELLOW SCRAP..... 226
MELTING HIGH-ZINC BRASS TURNINGS..... 226
POROUS BRASS BEARINGS..... 226
OVERCOMING POROSITY IN RED BRASS CASTINGS..... 226
GROWING VALUE OF THE NON-FERROUS SCRAP PILE..... 227
FURNACE SPECIALISTS INCORPORATE..... 228
STANDARD FOR CAST ZINC-BRONZE TEST SPECIMENS..... 229
MALLEABLE IRON, ITS CHARACTERISTICS, USES AND ABUSES..... 231
CHILLERS FOR CAST IRON CAR WHEELS..... 235
HOW PRACTICAL MEN CAN BROADEN THEMSELVES..... 236
A SUBSTITUTE FOR HAY ROPE IN A SOUTHERN FOUNDRY..... 240
SNYDER FURNACES ABROAD..... 240
PHILADELPHIA FOUNDRYMEN DISCUSS FIRE BRICK PROBLEMS..... 240
ELECTRIC FURNACE CONSTRUCTION AND OPERATION..... 241
HANDLING CRUCIBLES MADE WITH AMERICAN CLAY..... 245
FACING CAPACITY INCREASED..... 245
HOW PRODUCER GAS MADE FOUR-INCH PIPE POSSIBLE..... 246
A COMBINATION PATTERNMAKERS' TOOL..... 247
ANNUAL MEETING OF NEWARK FOUNDRYMEN..... 247
TRADE OUTLOOK..... 248
A NEW LINE OF SLIP RING INDUCTION MOTORS..... 249
STAMPED STEEL LADLE BOWLS..... 249
HAND JAR-RAMMING AND SQUEEZER MOLDING MACHINE..... 250
PORTABLE METER FOR HARDNESS TESTS..... 250
PERSONAL..... 250
CAST IRON PIPE PRODUCTION IN 1914..... 251
HARTFORD FOUNDRYMEN ENTERTAIN NEW ENGLAND MEMBERS..... 251
COST OF OXYGEN REDUCED..... 251
WHAT THE FOUNDRIES ARE DOING..... 251

Trade Outlook

SCARCITY of common labor continues to curtail foundry operations, although no shortage in skilled molders is reported from any of the leading foundry centers. This unusual condition is attributed to the great demand for unskilled operatives in the machinery and allied industries which are enjoying unusually high prices for their products and consequently are granting almost every concession to man their plants. The Pittsburgh district is the only section of the country where a determined stand has been taken by the foundrymen against shorter hours and an increased wage rate demanded by the molders, and upon the outcome of this controversy will depend largely the presentation of similar demands in other large casting centers. The reduced melt has been felt by the blast furnace operators to some extent, as their shipments have not been as heavy as during the months of March and April. In this connection, the tremendous merchant pig iron consumption must be taken into consideration, since the unfilled orders on furnace books considerably exceed the output of merchant stacks throughout the remainder of the year. While occasional soft spots have developed in pig iron quotations, no tendency towards weakness in existing prices for castings has been noted in any of the various branches of the foundry industry. Due to the activity of the rolling mills, the roll shops are from three to four months behind on deliveries and practically the same condition prevails among foundries specializing in rolling mill equipment. The jobbing shops in iron and steel works centers are crowded to capacity with orders for repair parts. Steel foundries likewise continue to enjoy unusual prosperity and prices for castings for early shipment are governed largely by the stress of the purchaser. With a record sale of motor cars and trucks confronting builders this season, shops specializing in castings for this industry still continue to operate at their maximum capacity, and it is predicted that the customary lull between seasons will not occur this year. The high prices prevailing for metals has not affected the output of the brass and aluminum foundries, but inability to obtain an adequate supply of tin and other white metals, as well as copper, has considerably reduced the output. In some instances forgings and malleable sections have been substituted for non-ferrous metal parts, but this practice also has been limited by the ability of forging plants and malleable shops to take on such work. The foundries generally are riding on the crest of the wave of prosperity and the continuation of existing conditions throughout the remainder of the year is assured. In the leading producing and consuming centers, foundry grades of pig iron are quoted as follows: No. 2, Chicago, $19; Cleveland, $19.30; Pittsburgh, $18.95; Buffalo, $18.25; Philadelphia, $20, and Birmingham, $14.50 to $15. Malleable is practically unchanged at $19.50, Chicago; $21.50 to $21.75, Philadelphia; $21, Buffalo, and $19.45 to $19.95, Pittsburgh. Lake Superior charcoal, Nos. 1 to 4, is held at $19.75 to $22.25, Chicago, and basic at $18.95 to $19.20, Pittsburgh, and $20.50 to $21, eastern Pennsylvania points. Non-ferrous metals continue on a high level, electrolytic copper being quoted at 29c to 29.25c, New York, and lake at 28.50c to 28.75c. Tin is nominally 48c; lead, 7.30c, and spelter, 14.25c to 14.50c.

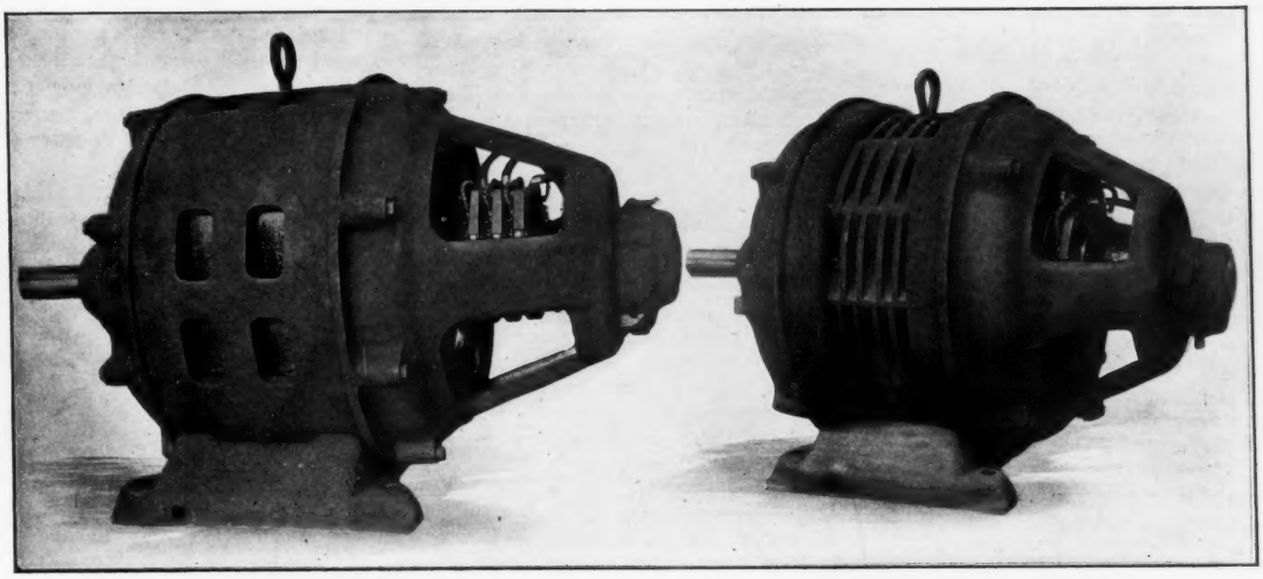


FIG. 1—SLIP RING INDUCTION MOTOR OF 75-HORSEPOWER CAPACITY WITH ROLLED STEEL FRAME

FIG. 2—SLIP RING INDUCTION MOTOR, 10-HORSEPOWER CAPACITY, WITH BUILT-UP FRAME

New Equipment for the Foundry

A NEW line of slip ring induction motors for severe, intermittent, varying speed service has been developed by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. They are particularly designed for heavy duty on cranes, hoists, transfer tables and similar applications and are furnished in sizes from 1½ to 200-horsepower for operation on two or three-phase, 220 or 240-volt, 25 and 60-cycle circuits. The frames of the smaller sizes, Fig. 2, are made up of steel laminations riveted between forged steel end shields and in the larger sizes the frames are made of rolled open-hearth steel. The brackets are cast iron with reinforcing ribs to insure rigidity and perfect alignment of the bearings, which are self-oiling of the oil-ring type and are large in size. The steel brush holders are supported by and insulated from the bracket, which is open to permit easy inspection and renewal of the brushes. The rotor is of small diameter, thereby reducing the flywheel effect. This feature, together with perfect balance and the secure attachment of the windings, make these motors especially adapted for frequent starting, stopping and reversing. The shaft is made of axle steel and can be removed from the rotor without disturbing the windings. The motors are so constructed that in case of accident, repairs can be made quickly. In the accompanying illustrations, a 75-horsepower motor is shown in Fig. 1, which is provided with a rolled steel frame and Fig. 2 is a view of a 10-horsepower motor with built-up frame construction.

FIG. 1—RANGE OF SIZES OF STAMPED STEEL LADLE BOWLS MANUFACTURED BY FREDERIC B. STEVENS, DETROIT

Stamped Steel Ladle Bowls

A complete line of stamped steel ladle bowls varying in capacity from 60 to 250 pounds, is being manufactured by Frederic B. Stevens, Detroit. Since these bowls are pressed out of a single piece of steel, they are without seams, joints or rivets and are made of extra heavy material. The bowl, which has a capacity of 250 pounds, is 13 inches in diameter and is made of steel 5/32-inch thick. The 200-pound capacity bowl is 12 inches in diameter and is made of ⅛-inch steel, while the 100 and 150-pound bowls likewise are made of ⅛-inch steel and are 10 inches and 11 inches in diameter, respectively. The bowl with a capacity of 60 pounds is 8¼ inches in diameter and is made of No. 14 gage steel. In connection with these bowls a ladle shank also is offered, the band being made of cast steel while the bars are inserted into the band casting with a machine fit and are held in place with a heavy rivet. This type of construction eliminates many difficulties experienced with forged bands and furthermore, there is practically no chance of the shank bending in the center.

FIG. 2—LADLE SHANK PROVIDED WITH A CAST STEEL BAND

According to recent statistics, Germany, under war conditions is producing electric steel at the rate of 129,646 metric tons annually. If the electric furnaces built by the Snyder Electric Furnace Co., Chicago, including those recently sold and in operation, were suddenly mobilized for war service and operating on a 24-hour basis, they would produce 77,975 tons of steel every 12 months, or 40 per cent of Germany's output.

Hand Jar-Ramming and Squeezer Molding Machine

An ingenious combination jar-ramming and squeezer molding machine has been developed by the B. & B. Mfg. Co., Indianapolis, on which the jar-ramming operations are performed by hand in place of by power. This machine can be operated either as a jar-rammer or a squeezer or as a combination of both. When operating the machine as a jar-rammer a quick stroke of the hand lever, shown in the vertical position in the accompanying illustration, sufficiently packs the sand and the amount of drop or force of the jar is controled by the motion given the lever. It is claimed that a mold can be jar-rammed with a drop of ⅛ to 1¼ inches, as the operator desires. When operating as a hand squeezer the

COMBINATION HAND JAR-RAMMER AND SQUEEZER MOLDING MACHINE

bail is moved forward and the hand lever is lowered to nearly a horizontal position for the final squeeze, the position of the handle being most convenient for the operator to perform the squeezing operation. The machine is simple in construction and consists of a main frame with a cylindrical machined barrel in which the table slide, consisting of a cylindrical sleeve, slides up and down. The stroke of the table is 2½ inches. All of the operating parts are contained within the table cylinder or sleeve and are thoroughly protected from the sand. All of the bearings have a slightly overhanging cap which prevents the sand from falling into them. The trunnions are protected with sand guards, making the joint between the trunnion and the machine frame sand-tight. This machine is built in three styles, namely, stationary, as illustrated herewith; portable, being mounted on four wheels, and of the wall bracket type. In the latter case wall brackets take the place of the two legs, knee brackets suspending the machine from the wall, providing a clear sand space underneath. The distance between the bail rods is 30 inches.

Portable Meter for Hardness Tests

An ingenious device, widely extending the application of the Brinell method for determining the hardness of metals and known as the Brinell meter, recently has been designed and placed on the market. Already it has been adopted in a number of large steel works, foundries, automobile plants and other metal working establishments. This instrument aims to overcome disadvantages which have attended the making of Brinell tests in a plant. These disadvantages include the impossibility of applying the test to any given spot of a large mass of metal such as rails, large castings, etc., or to irregularly shaped pieces or hollow metal bodies; the difficulty of making the tests on thin metal sheets of any kind because under pressure the ball penetrates the section; and finally, the fact that the apparatus could not be handled conveniently.

With the Brinell meter, these restrictions are said to be removed and the field of application greatly broadened. The instrument consists of a housing with a movable 10-millimeter ball projecting, and a detachable standard bar of carefully determined Brinell hardness which is inserted in the housing. The smooth surface of this bar contacts with the ball. Thus when pressure is applied, a spherically shaped impression is made in both the bar and in the metal under test. The diameters of the two indentations are measured by special scales. The hardness, which is in direct relation to the proportion of the two impressions, is determined from direct-reading tables which are supplied with the instrument. The pressure may be varied without affecting the accuracy of the tests since the method used is a comparative one. The meter also can be used as a hardness gage on steel purchased according to a certain specification.

The outfit consists of the housing, six standard bars, 12 standard steel balls, measuring scales, and direct-reading tables, all packed in a 9 x 6-inch leather carrying case. The outfit weighs only 6½ pounds. The meter was designed and patented by the metallurgical department of the Standard Roller Bearing Co. and is manufactured under a license agreement by Herman A. Holz, 50 Church street, New York City.

Personal

Daniel Gray, formerly connected with the Henry Vogt Machine Co., Louisville, has been appointed general foreman of the National Foundry & Machine Co., of that city.

T. Rice Davis has resigned as treasurer and general manager of the Vermilion Malleable Iron Co., Hoopeston, Ill. C. L. Liebau, secretary of the company also will serve as general manager.

Robert H. Kelley, formerly affiliated with the International Correspondence Schools, Scranton, Pa., has been appointed assistant sales manager of the Sand Mixing Machine Co., 52 Vanderbilt avenue, New York.

O. E. Thomas has been appointed district sales manager of the Terry Steam Turbine Co., Hartford, Conn., in the territory including Arizona and southern portions of California and

PORTABLE METER FOR MAKING HARDNESS TESTS

Nevada. His headquarters are in the Washington building, Los Angeles, Cal.

Henry Cave, of the Cave Welding & Mfg. Co., which has represented the Davis-Bournonville Co., New York, in New England for many years, will take active charge of the research department of the latter company, but will still retain his interest and will serve in an advisory capacity to the Cave Welding & Mfg. Co. To enable Mr. Cave to do this, the Davis-Bournonville Co. has arranged to take over the sale of its apparatus in the New England states, extending directly to that territory co-operative service from manufacturer to customer direct.

In 1915 the zinc properties in St. Lawrence county, N. Y., were actively developed, and a 200-ton mill was in successful operation during the latter part of the year. The Northern Ore Co. was the only producer of zinc in the state in 1915.

Cast Iron Pipe Production in 1914

According to a report issued by the United States census bureau, 69 establishments manufactured cast iron pipe in 1914, the total products of which were valued at $27,574,773. Of these 69 establishments the principal business of 61 was the manufacture of cast iron pipe and fittings, while the remaining eight which were engaged primarily in other lines of manufacture, produced cast iron pipe as a subsidiary line. At the census of 1909, 52 establishments were reported engaged in cast iron pipe manufacture with products valued at $29,153,723. The number of establishments in 1914 devoted strictly to the manufacture of cast iron pipe was greater by nine than the number reported in 1909, but the total value of the products decreased 9.6 per cent during the five-year period. The cast iron pipe output of 1914 comprised 1,092,208 net tons valued at $25,391,714 and consisted of 880,556 tons of gas and water pipe and fittings valued at $19,218,006 and 211,652 tons of soil and plumbers' pipe and fittings valued at $6,173,708. The gas and water pipe output was made up of 802,967 tons of bell and spigot pipe, valued at $16,228,587; 25,192 tons of flanged pipe, valued at $645,707; 12,001 tons of culvert pipe, valued at $246,527, and 40,386 tons of fittings, valued at $2,097,185. In addition, there were produced 26,199 tons of castings other than pipe and fittings, valued at $741,381 and products other than castings, valued at $1,441,678. Of the 69 establishments reported for 1914, 20 were located in Alabama, 10 in Pennsylvania, nine in New Jersey, seven in Ohio, four in New York, three in Michigan, three in Tennessee, three in Virginia, two in Illinois, two in Indiana and one each in Colorado, Georgia, Maryland, Massachusetts, North Carolina and Oregon.

Hartford Foundrymen Entertained New England Members

About 100 New England foundrymen and their friends were the guests, May 10, of the Hartford, Conn., members of the New England Foundrymen's Association. On that date, the Hartford group of members conducted the regular monthly meeting of the New England Foundrymen's Association. Upon arriving in Hartford, the visiting foundrymen and their friends assembled at the Allyn House, where automobiles were in waiting and visits were made to various plants about the city. In the evening, dinner was served at the Allyn House. In the discussions which followed, foundry costs in its several phases, sanitary conditions and other subjects pertaining to foundry management were given attention. Stephen E. French, president of the New England Foundrymen's Association presided and among those who spoke was A. F. Corbin of the Union Mfg. Co., New Britain, Conn.; Edw. Douglas of W. & B. Douglas, Middletown, Conn.; L. G. Kibbe of the Turner & Seymour Mfg. Co., Torrington, Conn., and others.

Cost of Oxygen Reduced

Since the beginning of the European war the cost of practically every commodity entering into manufacture has been greatly increased and this applies particularly to chemicals and their derivatives, which have soared to almost unheard of values. One commodity, however, has established an enviable record throughout the period following the outbreak of the war. The Linde Air Products Co., New York City, probably the largest manufacturer of commercial oxygen in the world, has maintained a policy of returning to the consumer, in the form of reduced prices, the benefits derived from its large increased production without reference to the tremendous advance in the cost of manufacture and distribution resulting from the present abnormal conditions. It is estimated, that on the average, the cost of oxygen to the consumer has been reduced approximately 15 per cent. The consumption of oxygen, by reason of the large increase in welding and other manufacturing operations has greatly increased in recent years and to keep pace with this growing demand the Linde Air Products Co. has established plants in the following centers: Atlanta, Ga.; Brooklyn, N. Y.; Buffalo, Cleveland, Detroit, East Chicago, Ind.; Elizabeth, N. J.; Milwaukee; Norristown, Pa.; North Kansas City, Mo.; Oakland, Cal.; Philadelphia, St. Louis, Trafford City, Pa.; Utica, N. Y., and Worcester, Mass.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Guelph Stove Co., Guelph, Ont., is building a foundry.

The Continuous Casting Co., Garwood, N. J., is extending its plant.

The Wheeling Mold & Foundry Co., Wheeling, W. Va., contemplates extending its plant.

The Junger Stove & Range Co., Grafton, Wis., will erect an addition to its plant.

The Reading Steel Casting Co., contemplates enlarging its plant.

The Thomas B. Jeffrey Co., Kenosha, Wis., is building a foundry, 125 x 600 feet.

The General Aluminum & Brass Mfg. Co., Detroit, contemplates enlarging its plant.

The National Steel Casting Co., Montpelier, Ind., will erect additions to its plant costing approximately $75,000.

The Vermillion Malleable Iron Co., Hoopeston, Ill., is building a 50 x 100-foot addition to its foundry.

The Standard Foundry Co. will move its plant from Alma to St. Louis, Mo., where it will erect a building, 100 x 160 feet.

The Dominion Stove & Foundry Co., Penetanguishene, Ont., will make extensive additions to its plant.

Gavin, Ritchie & Son, are building a foundry at Battle Creek, Mich., at a cost of $7,000.

The Gurney Foundry Co., Toronto, Ont., will erect an addition to its plant at a cost of $2,500.

Plans have been completed for a 40 x 60-foot foundry to be erected for James Kessler, Russell and Meserole streets, Brooklyn, N. Y.

The Manufacturers' Foundry Co., Milwaukee, is building a one-story, brick and steel addition, 84 x 100 feet.

The Davis & Furber Machine Co., North Andover, Mass., will build an addition to its foundry.

The Speakman Supply & Pipe Co., Wilmington, Del., will erect an addition to its foundry.

The Liebl & Retzloff Mfg. Co., Luxemburg, Wis., will build a 30 x 60-foot addition to its foundry and machine shop.

The Union Mould & Machine Co., Uniontown, Pa., will erect a brick foundry, 40 x 100 feet.

The Pennsylvania Engineering Works, New Castle, Pa., is building an addition to its foundry.

The Missouri Malleable Iron Co., East St. Louis, Ill., will build a foundry addition at a cost of $3,000.

The Minster Machine Co., Minster, O., is erecting a 60 x 84-foot brick addition to its foundry.

The Aetna Foundry & Machine Co., Warren, O., is building a foundry addition, 40 x 80 feet.

The Kutztown Foundry & Machine Co.,

Kutztown, Pa., contemplates building an addition to its foundry.

The John Illingworth Steel Co., Philadelphia, will erect a 12 x 27-foot foundry addition at a cost of $2,500.

The Lycoming Foundry & Machine Co., Williamsport, Pa., will build a 103 x 154-foot assembling shop and a 72 x 205-foot foundry.

The Syracuse Malleable Iron Works, Syracuse, N. Y., will build a 92 x 110-foot addition.

Plans are being prepared for an addition to the foundry of the Werra Aluminum Co., Waukesha, Wis.

The Gilderman Mfg. & Foundry Co., Syracuse, Ind., will move to Laporte, Ind., where it will erect a plant.

The Wm. A. Hardy & Sons Co., Fitchburg, Mass., has awarded the contract for the erection of an addition to its foundry.

The Vovaird Co., Bradford, Pa., will erect a 55 x 75-foot foundry to replace the one recently burned.

The Buckeye Foundry Co., Overpeck, O., is rebuilding its plant recently destroyed by fire.

The Pfau Mfg. Co., Norwood, O., manufacturer of plumbers' supplies, is having plans prepared for extending its plant.

The American Steel Foundries Co., Alliance, O., contemplates building a 65 x 150-foot addition to its plant.

A permit has been granted to the Enterprise Mfg. Co. of Pennsylvania, Third and Dauphin streets, Philadelphia, for the erection of a 50 x 58-foot addition to its foundry.

The Northwest Aluminum & Brass Foundry, Inc., Rochester, N. Y., will build a 50 x 120-foot foundry at a cost of approximately $10,000.

The Armstrong Steam Separator Co., Hobart, Okla., recently incorporated with $100,000 capital stock, will erect a foundry and machine shop.

William Johnson, owner of the Brooklyn Street Foundry Co., North Adams, Mass., contemplates erecting a foundry and machine shop.

The West Steel Castings Co., Cleveland, contemplates erecting a 60 x 175-foot addition to its plant. The building will be of steel construction and will cost $20,000.

A contract has been awarded for the erection of an additon to the plant of the Syracuse Chilled Die & Casting Co., Syracuse, N. Y.

The Hershey Machine & Foundry Co., Manheim, Pa., is erecting a brick addition, 53 x 156 feet, with an office adjoining, 24 x 34 feet.

The pattern storage and patternmaking department of the Knott & Harker Co., Beaver Falls, Pa., recently destroyed by fire, will be rebuilt immediately.

The Elwood Foundry Co., Elwood, Ind., has been organized to operate the plant of the Elwood Iron Works, which will be enlarged and new equipment added.

The National Pipe & Foundry Co., recently incorporated with $75,000 capital, by Wiley Alford, A. M. Shook and A. H. Campbell, will build a plant at Attalla, Ala., for the manufacture of cast iron soil pipe.

The Otis Elevator Co., Eleventh avenue and Twenty-sixth street, New York, is building a foundry addition and an assembling shop at its Harrison, N. J., plant. The estimated cost is $80,000.

Bids are being received by McLaughlin & Hulsken, Lima, O., for a four-story and basement, 50 x 150-foot pattern shop to be erected for the Carroll Foundry & Machine Co., Bucyrus, O.

Work has been started on the 1-story, 125 x 400-foot addition to the tank house of the United States Metals Refining Co., Chrome, N. J. The company also will build a 2-story, 51 x 115-foot laboratory, foundry and storage building.

The Electric Steel Castings Co., Milwaukee, has commenced work on its electric steel foundry. The first unit will consist of three buildings, 30 x 80 feet, 40 x 200 feet, and boiler house, 30 x 40 feet, of brick, steel and concrete construction.

The General Chemical Co. of New York, has purchased the plant of the Pulaski Foundry & Machine Co., Pulaski, Va., and will make castings and machinery for its 25 plants. A new company has been organized under the name of the Pulaski Foundry & Machine Co., which will build a foundry, 40 x 130 feet, and a machine shop, 40 x 130 feet.

The Bay View Foundry Co., Sandusky, O., manufacturer of gray iron castings for automobile, marine and stationary gas engine parts, has awarded contracts for an addition to its foundry, 65 x 150 feet and an extension to its cleaning room, 25 x 90 feet. These are the second additions made by this company during the last eight months and are necessary to provide capacity for the constantly growing demand for its product. The contracts provide for the completion of these extensions within 100 days.

General Industrial Notes

The Ornamental Casting Co., 122 Wooster street, New York, has established a foundry for casting white metal of all kinds.

Mayer Bros. have taken over the foundry and machine shop of the International Hoist Co., Antigo, Wis.

The Hoosier Castings Co., Connersville, Ind., has increased its capital stock from $35,000 to $50,000.

The Springfield Brass Co., Springfield, Vt., recently has added a gray iron casting department.

The Hubbard Steel Foundry Co., East Chicago, Ind., has increased its capital stock from $500,000 to $1,000,000.

The General Castings Corporation, Buffalo, has been incorporated with $5,000 capital, by E. L. Stutt, B. S. Linelty and W. H. Means.

The Central Foundry Co., Vincennes, Ind., which has been closed since September, 1914, will resume operations.

The Burlington Separator Co., Burlington, Ia., is seeking a building in which it will install foundry and machine shop equipment.

The John Woods Mfg. Co., Conshohocken, Pa., has been incorporated with a capital of $50,000. A brass and aluminum foundry, machine and pattern shops, etc., will be built.

The Bayshore Foundry Co., Pensacola, Fla., has been incorporated with a capital stock of $5,000, by W. N. Ford, J. A. Stauter and others.

The Peerless Brass Foundry & Machinery Co., South Bend, Ind., has been incorporated with a capital stock of $1,000 by J. H. Woodward, Robert F. Miller and John A. Wilskey.

The South Shore Foundry Co., Chicago, has been incorporated with a capital stock of $2,500, by Allis Perz, William Riddle and Albert H. Victor, 227 Swan street.

The Fahnestock Mfg. Co., Union Bank building, Pittsburgh, has acquired a plant at Avonmore, Pa., and will operate a gray iron foundry.

The plant of the Utica Pipe Foundry Co., Utica, N. Y., which went into bankruptcy several years ago, will be placed in operation by a new organization.

The Republic Brass Co., 1767 East Eighteenth street, Cleveland, has been organized by E. H. Blywise to engage in the manufacture of plumbers' brass goods.

The Pontiac Gray Iron Co., Pontiac, Mich., recently organized, has acquired the foundry department of the Pontiac Machine & Foundry Co.

The Denver Boiler & Iron Works is negotiating with the chamber of commerce of El Paso, Texas, with a view of establishing a foundry in that city.

The East End Brass & Ingot Co., Waterbury, Conn., is building a two-story 60 x 200-foot plant; a two-story office building and a boiler house.

The Detroit Bearing & Casting Co., 75 West Baltimore avenue, Detroit, has been incorporated with $110,000 capital by Edward H. Mills, Thomas P. Nerny and Fred J. Candt.

The Howard Stove Co., Beaver Falls, Pa., has been absorbed by the Zenith Stove & Heater Co., of that place, but with main offices in Pittsburgh. J. C. Bash is general manager of the consolidated plants.

The Metal & Alloy Specialties Co., Buffalo, has been incorporated with $10,000 capital to engage in the manufacture of bronze and aluminum castings. The incorporators are E. A. Moore, M. C. Teall and E. Rae.

A ship building plant, which will include a steel foundry, machine shop and woodworking department, will be erected by Boyd's, Ltd., at Port Moody, B. C. The estimated cost is $200,000.

The Malleable Iron Range Co., Beaver Dam, Wis., is erecting an office and shop building. The office building will be of brick, one story and basement, 65 x 100 feet, and the foundry of brick and mill construction, 50 x 200 feet.

The Doty Engine Co., Toronto, Ont., has been incorporated with a capital stock of $100,000 to engage in the manufacture of castings and other metal products. The incorporators are J. S. Lovell, W. Bain and J. J. Dashwood.

The Doehler Die-Casting Co., operating plants at Brooklyn, N. Y., and Toledo, O., has acquired a controlling interest in the American Die Casting Co., Newark, N. J., which will be known hereafter as the Doehler Die-Casting Co. of New Jersey.

The Reliance Foundry, Montreal, Que., has been incorporated with $50,000 capital to engage in the manufacture of soil pipe, stoves, furnaces, etc. The incorporators are Emilien Daoust, Antonia Valiquette and Joseph A. St. Yves.

The Rex Brass Co., Cleveland, has been incorporated with a capital stock of $1,000 to engage in the manufacture of plumbers' supplies. M. W. Kastriner, B. Foniger, S. Braverman, V. E. Woodman and A. Elsner are the incorporators.

The Cherry Tree Machine Co., Cherry Tree, Pa., has been incorporated with a capital of $25,000, by J. C. Cosgrove, H. V. Brown and C. T. Paul. The new company has taken over the Cherry Tree Iron Works and will operate a foundry and machine shop for the manufacture of mine cars, etc.

The Maxwell Foundry Co., Rome, N. Y., has been incorporated with a capital stock of $25,000 to engage in the manufacture of bronze, iron and steel castings. The incorporators are H. B. Maxwell, M. H. Maxwell, 501 Willard street, Rome, and T. H. Hughes, 1527 Howard avenue, Utica, N. Y.

The merger of the Penn Steel Castings & Machine Co., Chester, Pa., and the Baldt Steel Co., New Castle, Del., has been effected and the new company will be known as the Penn Marine & Ordnance Castings Co. The general offices will be located at 132 South Fifteenth street, Philadelphia. The officers follow: Rodney Thayer, president; Walter S. Bickley, vice president; C. Ferris Jemison, secretary and Ivers S. Adams, treasurer.